# Agilent 1100 Series Nano Pump

## Service Manual

Agilent Technologies

# Notices

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## Warning Symbols Used on the Instrument

The apparatus is marked with this symbol when the user should refer to the instruction manual in order to prevent risk of harm to the operator and to protect the apparatus against damage.

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## 1 Installing the Pump

How to install the nano pump.

## 2 Troubleshooting and Test Functions

The nano pump's built-in troubleshooting and test functions

## 3 Repairing the Pump

Instructions on simple, routine repair procedures as well as more extensive repairs requiring exchange of internal parts

## 4 Parts and Materials

Detailed illustrations and lists for identification of parts and materials

## 5 Introduction to the Nano Pump

An introduction to the nano pump, instrument overview, theory of operation, external communication and internal connectors

## 6 Control Module Screens for the Nano Pump

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For any information about running and optimizing your nano pump please refer to the nano pump user manual.

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# Site Requirements

A suitable environment is important to ensure optimum performance of the nano pump.

## Power Consideration

The nano pump power supply has wide ranging capability (see Table 1 on page 3). It accepts any line voltage in the range described in the above mentioned table. Consequently there is no voltage selector in the rear of the nano pump. There are also no externally accessible fuses, because automatic electronic fuses are implemented in the power supply.

**WARNING** **To disconnect the nano pump from line, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.**

**CAUTION** **Shock hazard or damage of your instrumentation can result, if the devices are connected to a line voltage higher than specified.**

## Power Cords

Different power cords are offered as options with the nano pump. The female end of each of the power cords is identical. It plugs into the power-input socket at the rear of the nano pump. The male end of each of the power cords is different and designed to match the wall socket of a particular country or region.

**WARNING** **Never operate your instrumentation from a power outlet that has no ground connection. Never use a power cord other than the power cord designed for your region.**

**WARNING** **Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.**

## Bench Space

The nano pump dimensions and weight (see Table 1) allow to place the nano pump on almost any laboratory bench. It needs an additional 2.5 cm (1.0 inches) of space on either side and approximately 8 cm (3.1 inches) in the rear for the circulation of air and electric connections.

If the bench should carry a complete Agilent 1100 Series system, make sure that the bench is designed to carry the weight of all the modules.

NOTE The pump should be operated in a horizontal position!

## Environment

Your nano pump will work within specifications at ambient temperatures and relative humidity as described in Table 1.

**CAUTION** Do not store, ship or use your nano pump under conditions where temperature fluctuations could cause condensation within the nano pump. Condensation will damage the system electronics. If your nano pump was shipped in cold weather, leave it in its box and allow it to warm slowly to room temperature to avoid condensation.

**Table 1** Physical Specifications

| Type | Specification | Comments |
|---|---|---|
| Weight | 17 kg (39 lbs) | |
| Dimensions (height × weight × depth) | 180 × 345 × 435 mm (7 × 13.5 × 17 inches) | |
| Line voltage | 100 – 120 or 220 – 240 VAC, ± 10 % | Wide-ranging capability |

**Table 1** Physical Specifications, continued

| | | |
|---|---|---|
| Line frequency | 50 or 60 Hz, ± 5 % | |
| Power consumption (apparent power)<br>Power consumption (active power) | 220 VA<br>75 W | Maximum<br>Maximum |
| Ambient operating temperature | 4 – 55 °C (41 – 131 °F) | |
| Ambient non-operating temperature | -40 – 70 °C (-4 – 158 °F) | |
| Humidity | < 95 %, at 25 – 40 °C (77 – 104 °F) | Non-condensing |
| Operating Altitude | Up to 2000 m (6500 ft) | |
| Non-operating altitude | Up to 4600 m (14950 ft) | For storing the nano pump |
| Safety standards: IEC, CSA, UL | Installation Category II, Pollution Degree 2 | |

# Unpacking the Nano Pump

### Damaged Packaging

Upon receipt of your nano pump, inspect the shipping containers for any signs of damage. If the containers or cushioning material are damaged, save them until the contents have been checked for completeness and the nano pump has been mechanically and electrically checked. If the shipping container or cushioning material is damaged, notify the carrier and save the shipping material for the carrier's inspection.

**CAUTION** If there are signs of damage to the nano pump, please do not attempt to install the nano pump.

### Delivery Checklist

Ensure all parts and materials have been delivered with the nano pump. For this compare the shipment content with the checklist included in the instrument box. Please report missing or damaged parts to your local Agilent Technologies sales and service office.

### Accessory Kit

Each shipment contents an accessory kit with the necessary tools to install the pump and to have an operating system.

**Table 2** Nano Pump Accessory Kit Content G2226-68705

| Description | Part Number |
|---|---|
| Insert tool | 01018-23702 |
| SST Solvent inlet filter (x4) | 01018-60025 |
| Waste tube (2 m) | 0890-1760 |
| SST replacement frit (0.5 µm) | 5022-2185 |
| Wrench open end 7/16 - 1/2 inch (x 2) | 8710-0806 |

**Table 2** Nano Pump Accessory Kit Content G2226-68705, continued

| Description | Part Number |
|---|---|
| Wrench open end 1/4 - 5/16 inch (x1) | 8710-0510 |
| Wrench open end 14 mm (x 1) | 8710-1924 |
| Wrench open end 4 mm, (x 1) | 8710-1534 |
| Hex key 2.5 mm, 15 cm long, straight handle (x 1) | 8710-2412 |
| Hex key 3.0 mm, 12 cm long (x 1) | 8710-2411 |
| Hex key 4.0 mm, 15 cm long, T handle (x 1) | 8710-2392 |
| Torque adapter | G1315-45003 |
| CAN cable (1 m long) | 5181-1519 |
| Purge valve assembly | G1311-60009 |
| Purge valve holder | G1312-23200 |
| Screw for the purge valve holder | 0515-0175 |
| FS to Inj valve cap. (350 mm, 25 µm) | G1375-87322 |
| FS to Inj valve cap. (550 mm, 25 µm) | G1375-87323 |
| Flow sensor accuracy calibration capillary (8000 mm, 25 µm) | G2226-67300 |
| ESD wrist strap | 9300-1408 |

## Optimizing the Stack Configuration

If your nano pump is part of a complete 1100 series system, you can ensure optimum performance by limiting the configuration of the system stack to the following configuration. This configuration optimizes the system flow path, ensuring minimum delay volume.

NOTE If a single stack configuration becomes too high, e.g. if an additional module like a G1330B ALS Thermostat is added or if your bench is too high, a two stack configuration may be a better setup. Separate the stack between pump and sampler and place the stack containing the pump on the right side of the stack containing the sampler.

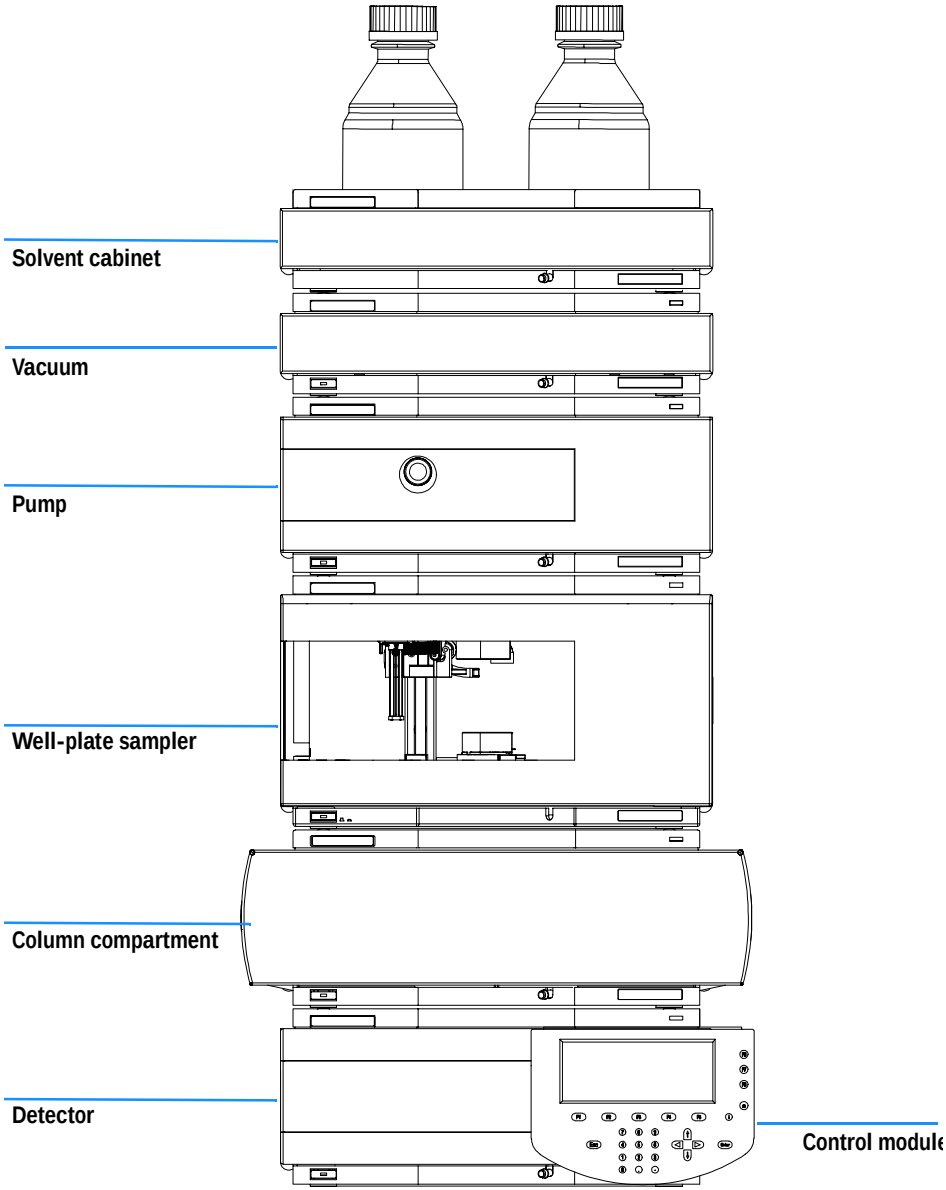


**Figure 1** Recommended Stack Configuration (Front View)

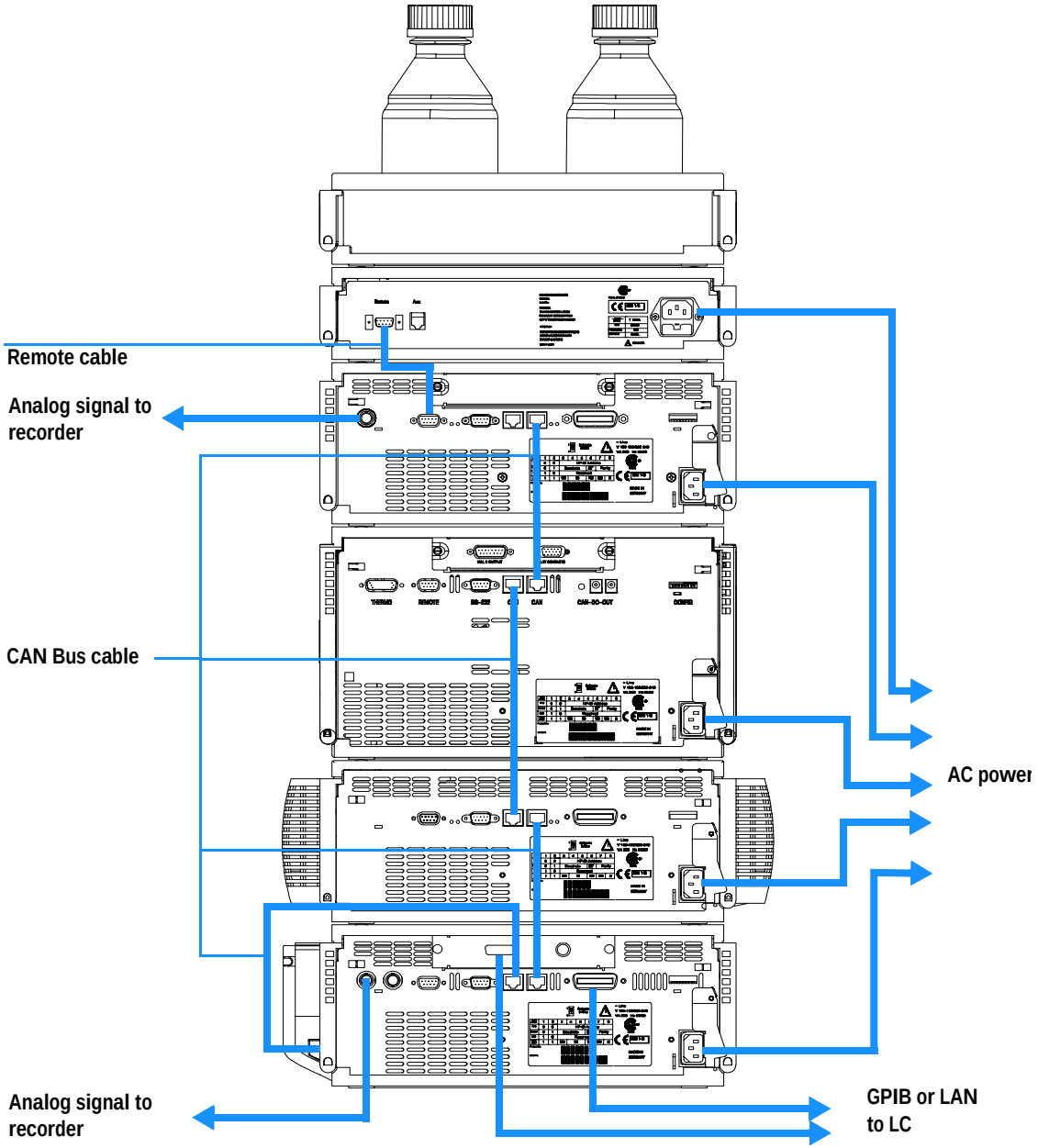


**Figure 2** Recommended Stack Configuration (Rear View)

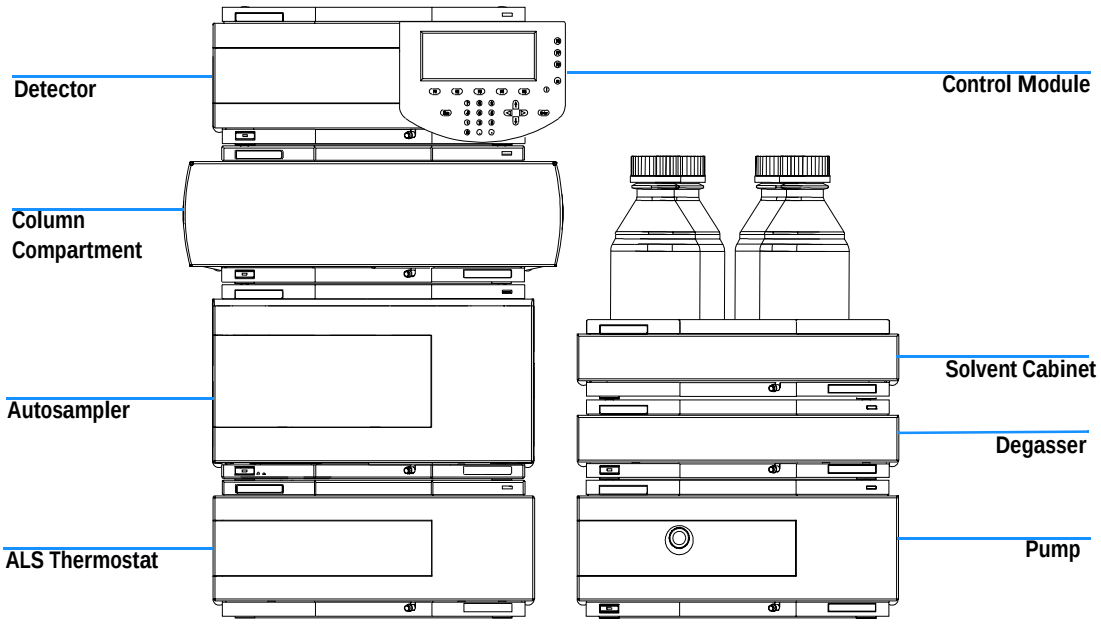


**Figure 3** Recommended stack configuration (front view)

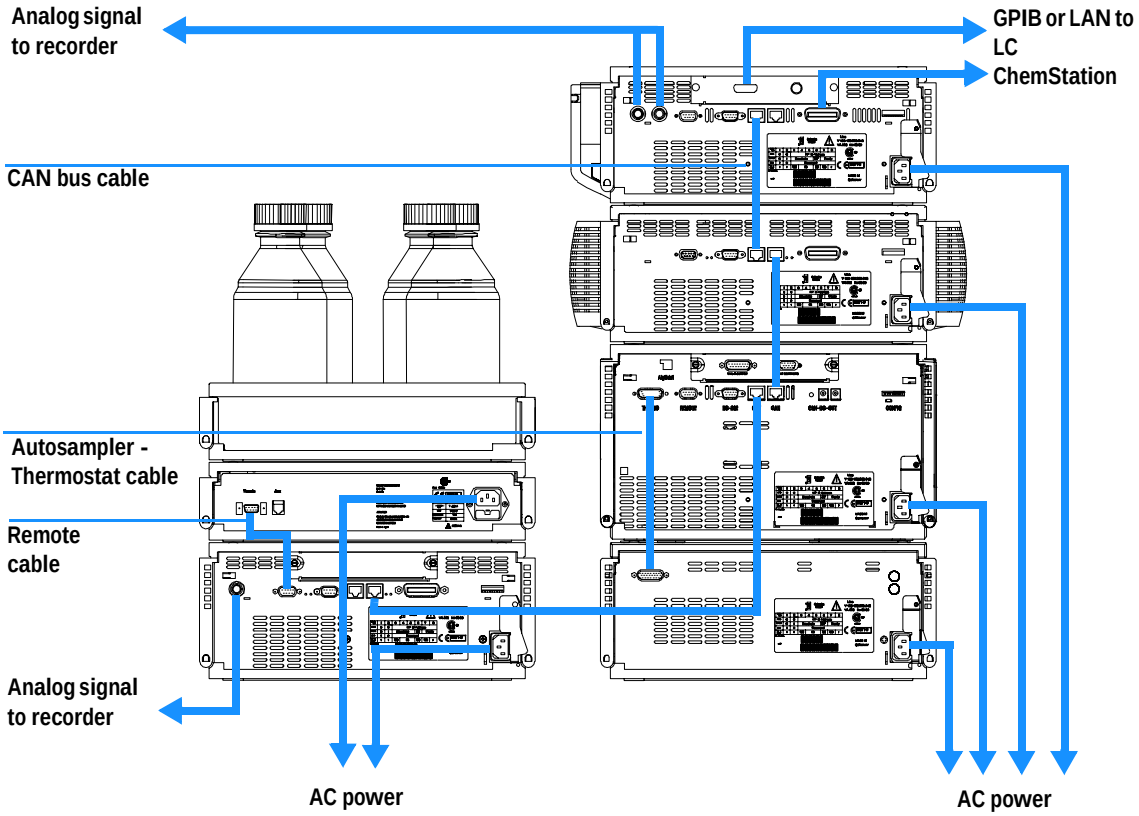


**Figure 4** Recommended stack configuration (rear view)

# Installing the Nano Pump

| | |
|---|---|
| **Preparations** | Locate bench space<br>Provide power connections<br>Unpack the pump |
| **Parts required** | Pump<br>Parts from accessory kit (see “Nano Pump Accessory Kit Content G2226-68705” on page 5)<br>Power cord, for other cables see text below and “Cable Overview” on page 174<br>ChemStattion and/or Control module G1323A/B |

**WARNING** **When opening capillary or tube fittings solvents may leak out. Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

NOTE Ensure the line power switch at the front of the pump is off.

## Installing the Nano Pump

1 Place the pump on top of the micro-sampler. Make sure that the two modules are interlocked correctly.

2 Connect the power cable to the power socket at the rear of the pump. Do not connect the power cable to power until you have finished the hardware installation of all modules in the stack.

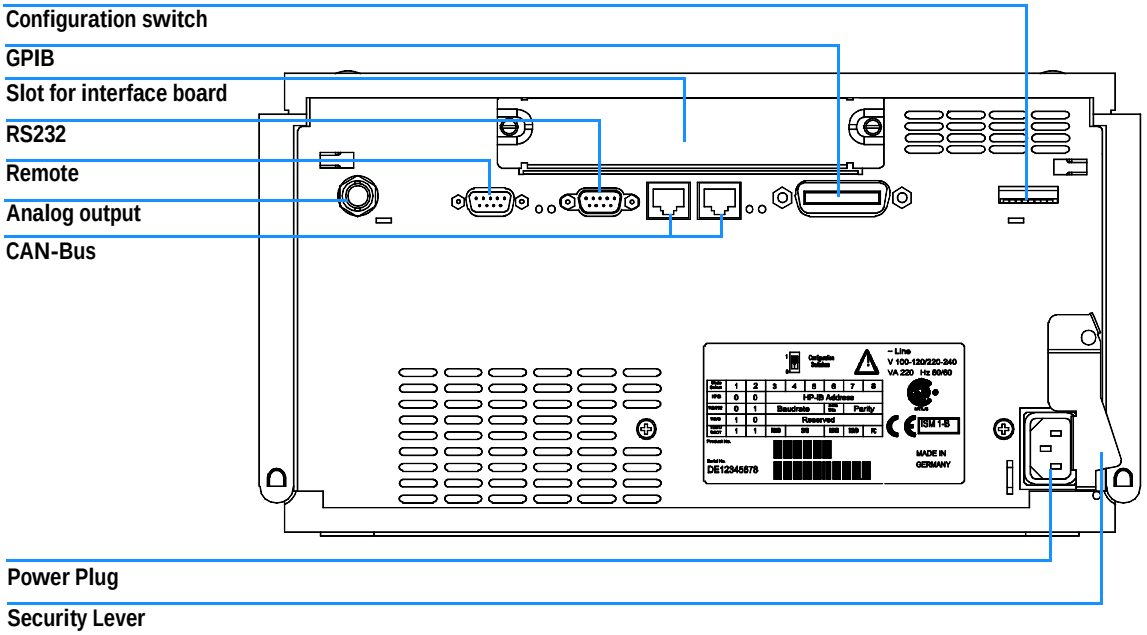


**Figure 5** Rear of Nano Pump

3 Connect the free end of the Can-bus cable from the micro-sampler to one of the Can-bus connectors at the rear of the pump.

NOTE In an Agilent 1100 Series system, the individual modules are connected through CAN cables. The Agilent 1100 Series vacuum degasser is an exception. A vacuum degasser can be connected via the APG remote connector to the other modules of the stack. The AUX output allows the user to monitor the vacuum level in the degasser chamber. An Agilent 1100 Series control module can be connected to the CAN bus at any of the modules in the system except for the degasser. The Agilent ChemStation can be connected to the system through one GPIB or LAN (requires the installation of a LAN- board) cable at any of the modules (except for the degasser), preferably at the detector (MUST for the DAD).

For more information about connecting the control module or Agilent ChemStation refer to the respective user manual. For connecting the Agilent 1100 Series equipment to non-Agilent 1100 Series equipment, see "Introduction to the Nano Pump" on page 193.

4 Connect the pre-terminated end of the pump-to-sampler capillary (G1375-87322 or G1375-87323) to the flow sensor outlet of the pump. Connect the other end of this capillary to port 1 of the sampler injection valve.

NOTE Carefully route all capillaries so that they are not crushed or broken by module front covers. Avoid excessive bending.

5 Connect the 1/8 inch plastic EMPV waste tube to the barbed waste fitting of the EMPV. Route the waste tube to an appropriate waste container.

NOTE The pump was shipped with default configuration settings. To change these settings, see "Setting the 8-bit Configuration Switch" on page 223.

**WARNING** **To disconnect a module from line, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.**

## Install the Degasser (G1379A)

**CAUTION** Ensure the line power switch at the front of the degasser is off.

1 Place the degasser on top of the pump. Make sure that the two modules are interlocked correctly.

2 Connect one end of the remote cable (5061-3378) to the rear of the degasser. Connect the other end of the cable to the remote port at the rear of the pump.

3 The degasser accessory kit has a set of 4 solvent tubes (G1322-67300). Each tube is labeled A, B, C or D. Connect each solvent tube to its intended OUTLET channel port on the degasser. Connect the other end of the solvent tube to its intended port at the pump solvent selection valve. Follow the guide below:

| **Degasser OUTLET** | | Pump Solvent Selection **Valve Port** |
|---|---|---|
| A | to | A1 (left half, upper) |
| B | to | A2 (left half, lower) |
| C | to | B1 (right half, upper) |
| D | to | B2 (right half, lower) |

## Install the Solvent Cabinet

1 The solvent cabinet accessory kit has 4 bottle head assemblies (G1311-60003).

2 Connect a bottle head assembly to each of the degasser INLET ports. Use the labels provided with each bottle head assembly to appropriately label each bottle head assembly.

3 Purge your system before first use (see “Get the System Ready for the First Injection” on page 17).

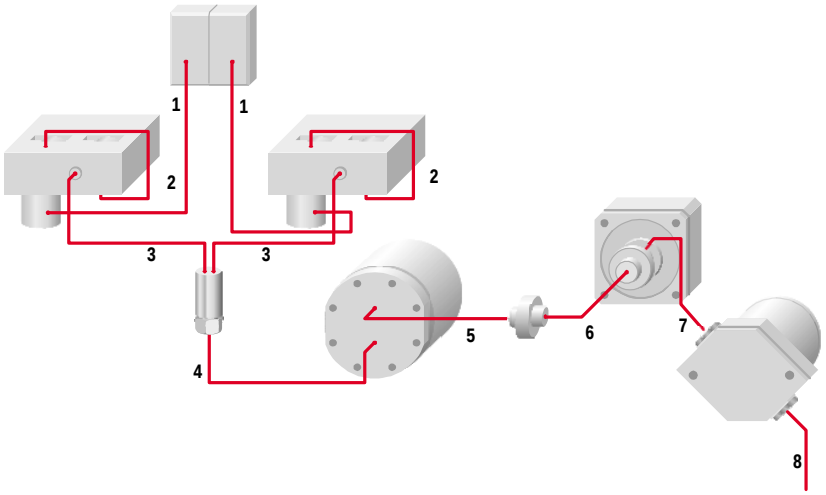


**Figure 6** Flow connection of the capillary pump

**Table 3** Connecting capillaries for the Nano Pump

| Item | Part Number |
|---|---|
| 1 | G1311-67304 |
| 2 | G1312-67300 |
| 3 | G1312-67302 |
| 4 | G1312-67304 |
| 5 | 01090-87308 |
| 6 | G1375-87400 |
| 7 (220 mm, 25 µm) | G1375-87321 |
| 8 (350 mm, 25 µm) | G1375-87322 |
| 8 (550 mm, 25 µm) | G1375-87323 |

# Get the System Ready for the First Injection

When you are using the system for the first time after installation, best results are obtained by performing the following 3-step system preparation, in the order given below:

1 Manually priming the solvent channels.

2 Purging the pump.

**WARNING** **When opening capillary or tube fittings, solvents may leak. Please observe appropriate safety precautions (such as eye protection, safety gloves, protective clothing) as described in the material handling information and safety data sheet supplied by the solvent vendor, especially when hazardous solvents are used.**

## Manually Priming the Solvent Channels

NOTE This procedure should be done before the modules are turned on.

1 The degasser accessory kit contains a 20ml plastic syringe and a solvent tube adapter for this syringe. Push the adapter onto the syringe.

2 Pour the intended analytical solvents into the solvent bottles, and install the bottles on the desired solvent channels. Install Isopropanol on channels which will not be used right away.

3 Put a paper towel over the leak sensor in the pump leak tray.

4 Disconnect the channel A solvent tube from the A1 port of the pump solvent selection valve.

**WARNING** **Liquid may drip from the disconnected solvent tube. Make sure to follow appropriate safety precautions.**

5 Connect the end of the solvent tube to the syringe adapter. Slowly draw a syringe volume (20ml) from the solvent tube.

6 Disconnect the solvent tube from the syringe adapter, and reconnect the tube to the A1 port of the solvent selection valve. Eject the syringe contents into an appropriate waste container.

7 Repeat steps 4 to 6 for the three remaining solvent channels.

8 When all 4 solvent channels are manually primed, remove the paper towel from the pump leak tray. Make sure that the pump leak sensor is dry before turning on the pump.

## Purging the Pump

1 Make sure that the 1/8 inch plastic waste tube is tightly connected to the barbed waste fitting of the pump EMPV, and routed to an appropriate waste container.

2 Turn on the LC System. All system parameters should be set to default. The degasser should also be turned on at this time.

3 Initialize the system. Then, access the pump controls and make sure the pump mode is set to Normal.

4 Access the pump Purge control. Set up a purge table which will purge all channels for 5 minutes each, at a flow of 2500 µl/min. Then, start the purge.

NOTE When the pump has been turned off for a certain time (for example, overnight), oxygen will re-diffuse into the channels between the degasser and the pump. It is suggested to purge each channel at 2500 µl/min for 1 minute at the beginning of each day.

**Table 4** Choice of Priming Solvents for Different Purposes

| Activity | Solvent | Comments |
|---|---|---|
| After an installation | Isopropanol | Best solvent to flush air out of the system |
| After an installation (second choice) | Ethanol or Methanol | Alternative to Isopropanol if no Isopropanol is available |
| When switching between reverse phase and normal phase (both times) | Isopropanol | Best solvent to flush air out of the system |

**Table 4** Choice of Priming Solvents for Different Purposes, continued

| Activity | Solvent | Comments |
|---|---|---|
| To clean the system when using buffers | Bidistilled water | Best solvent to re-dissolve salts |
| After a solvent change | Bidistilled water | Best solvent to re-dissolve salts |
| After the installation of normal phase seals (P/N 0905-1420) | Hexane + 5% Isopropanol | Good wetting properties |
| To clean the capillaries | Acetone | Best solvent to remove impurities from the capillaries |

# 1 Installing the Pump

# 2 Troubleshooting and Test Functions

Status Indicators 23
Error Messages 25
Testing your Nano Pump 65
Basic System Troubleshooting 92

This chapter describes the pump's built in troubleshooting and test functions:

### Status Indicators

The nano pump is provided with two status indicators which indicate the operational state (prerun, run, and error states) of the nano pump. The status indicators provide a quick visual check of the operation of the nano pump ("Status Indicators" on page 23).

### Error Messages

In the event of an electronic, mechanical or hydraulic failure, the nano pump generates an error message in the user interface. The following pages describe the meaning of the error messages. For each message, a short description of the failure, a list of probable causes of the problem, and a list of suggested actions to fix the problem are provided ("Error Messages" on page 25).

### Micro Pressure Test

This is a fast test to verify the tightness of a micro system, where the pump is operating in the micro mode and no manual purge valve is installed. The pump is operating in the pressure control mode at 380 bar for several minutes. The remaining flow in the column flow path between the EMPV and the blank nut is measured. ("Testing your Nano Pump" on page 65).

### Pressure Test

The pressure test is a quick, built-in test designed to demonstrate the pressure-tightness of the system. The test should be used when problems with leaks are suspected, or after maintenance of flow-path components (e.g., pump seals, injection seal) to prove pressure tightness up to 400 bar. The test involves monitoring the pressure profile as the nano pump runs through a predefined pumping sequence. The resulting pressure profile provides information about the pressure tightness of the system. ( "Normal Mode Pressure Test" on page 68).

### Leak Test

The leak test is a diagnostic test designed to determine the pressure tightness of the nano pump. Especially when a problem with the pistons the AIV or the OBV is suspected, use this test to help troubleshoot the nano pump and its pumping performance ("Leak Test" on page 73).

### EMPV Test

The test is designed to verify the performance of the EMPV. The test must always be done when the EMPV valve is exchanged. The test should also be done if column flow stability problems occurs in micro mode (see)

The EMPV test is not a substitute for the leak test or pressure test. The leak and pressure tests should also be done when leaks within the pump heads might be the problem ("EMPV Test" on page 84)

### Flow Sensor Accuracy Calibration

The flow sensor accuracy calibration test is designed to calibrate the flow accuracy and to compensate the electronic offset of the nano flow sensor. This test should be done if high flow accuracy is needed at flow rates lower than 500 nl/min.

The calibration of the flow sensor is based in the linear relationship between the flow rate and pressure drop in a capillary. The zero point is corrected and calibration factors are evaluated ("Flow Sensor Accuracy Calibration" on page 86)

# Status Indicators

Two status indicators are located on the front of the nano pump. The lower left one indicates the power supply status, the upper right one indicates the instrument status.

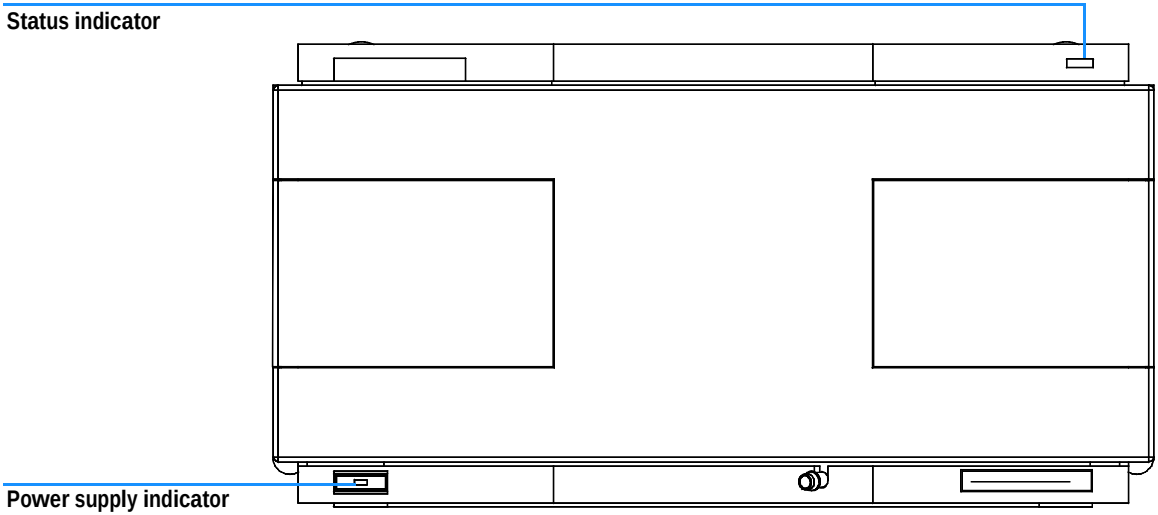


**Figure 7** Location of Status Indicators

## Power Supply Indicator

The power supply indicator is integrated into the main power switch. When the indicator is illuminated (*green*) the power is **ON**.

When the indicator is off, the module is turned off. Otherwise check power connections, availability of power or check functioning of the power supply.

## Instrument Status Indicator

The instrument status indicator indicates one of four possible instrument conditions:

- When the status indicator is **OFF** (and power switch light is on), the nano pump is in a *prerun* condition, and is ready to begin an analysis.
- A *green* status indicator, indicates the nano pump is performing an analysis (*run* mode).
- A *yellow* indicator indicates a ***not-ready*** condition. The nano pump is in a not-ready state when it is waiting for a specific condition to be reached or completed (for example, immediately after changing a setpoint), or while a self-test procedure is running.
- An *error* condition is indicated when the status indicator is *red*. An error condition indicates the nano pump has detected an internal problem which affects correct operation of the instrument. Usually, an error condition requires attention (for example, leak, defective internal components). An error condition always interrupts the analysis.
- A *flashing yellow* status indicator indicates that the module is in its *resident mode*. Call your local service provider for assistance upon observing this error condition.
- A *flashing red* status indicator indicates a severe error during the *startup* procedure of the module. Call your local service provider for assistance upon observing this error condition.

## Error Messages - Indication

Error messages are displayed in the user interface when an electronic, mechanical, or hydraulic (flow path) failure occurs which requires attention before the analysis can be continued (for example, repair, frit exchange or exchange of consumables required). In the event of such a failure, the red status indicator at the front of the module is switched on, and an entry is written into the instrument logbook.

# Error Messages

Select the error-message you are looking for in the list below.

Each of the error-messages is described in detail on the indicated page. For each one possible causes are discussed and actions to solve the problem are suggested

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## Time-out

The time-out threshold was exceeded.

### Probable Causes

- The analysis was completed successfully, and the time-out function switched off the nano pump as requested.
- A not-ready condition was present during a sequence or multiple-injection run for a period longer than the time-out threshold.

### Suggested Actions

✔ Check the logbook for the occurrence and source of a not-ready condition. Restart the analysis where required.

## Shutdown

An external instrument has generated a shut-down signal on the remote line.

The nano pump continually monitors the remote input connectors for status signals. A LOW signal input on pin 4 of the remote connector generates the error message.

### Probable Causes

- Leak detected in another module with a CAN connection to the system.
- Leak detected in an external instrument with a remote connection to the system.
- Shut-down in an external instrument with a remote connection to the system.
- The degasser failed to generate sufficient vacuum for solvent degassing.

### Suggested Actions

✔ Fix the leak in the external instrument before restarting the nano pump.

✔ Check external instruments for a shut-down condition.

✔ Check the vacuum degasser for an error condition. Refer to the *Reference Manual* for the Agilent 1100 Series vacuum degasser.

## Remote Time-out

A not-ready condition is still present on the remote input.

When an analysis is started, the system expects all not-ready conditions (e.g. a not-ready condition during detector balance) to switch to run conditions within one minute of starting the analysis. If a not-ready condition is still present on the remote line after one minute the error message is generated.

### Probable Causes

- Not-ready condition in one of the instruments connected to the remote line.
- Defective remote cable.
- Defective components in the instrument showing the not-ready condition.

### Suggested Actions

✔ Ensure the instrument showing the not-ready condition is installed correctly, and is set up correctly for analysis.

✔ Exchange the remote cable.

✔ Check the instrument for defects (refer to the instrument's reference documentation).

## Synchronization Lost

During an analysis, the internal synchronization or communication between one or more of the modules in the system has failed.

The system processors continually monitor the system configuration. If one or more of the modules is no longer recognized as being connected to the system, the error message is generated.

### Probable Causes

- CAN cable disconnected.
- Defective CAN cable.
- Defective main board in another module.

### Suggested Actions

✔ Ensure all the CAN cables are connected correctly.

✔ Switch off the system. Restart the system, and determine which module or modules are not recognized by the system.

✔ Ensure all CAN cables are installed correctly.

## Leak

A leak was detected in the nano pump.

The signals from the two temperature sensors (leak sensor and board-mounted temperature-compensation sensor) are used by the leak algorithm to determine whether a leak is present. When a leak occurs, the leak sensor is cooled by the solvent. This changes the resistance of the leak sensor which is sensed by the leak-sensor circuit on the CSM board.

### Probable Causes

- Loose fittings.
- Broken capillary.
- Loose or leaking active inlet valve, outlet ball valve, or EMPV.
- Defective pump seals.

### Suggested Actions

✔ Ensure all fittings are tight.

✔ Exchange defective capillaries.

✔ Ensure pump components are seated correctly. If there are still signs of a leak, exchange the appropriate seal (active inlet valve, outlet ball valve).

✔ Exchange the pump seals.

## Leak Sensor Open

The leak sensor in the nano pump has failed (open circuit).

The current through the leak sensor is dependent on temperature. A leak is detected when solvent cools the leak sensor, causing the leak-sensor current to change within defined limits. If the current falls outside the lower limit, the error message is generated.

### Probable Causes

- Leak sensor not connected to the CSM board.
- Defective leak sensor.
- Leak sensor incorrectly routed, being pinched by a metal component.

### Suggested Actions

✔ Ensure the leak sensor is connected correctly.

✔ Exchange the leak sensor.

## Leak Sensor Short

The leak sensor in the nano pump has failed (short circuit).

The current through the leak sensor is dependent on temperature. A leak is detected when solvent cools the leak sensor, causing the leak-sensor current to change within defined limits. If the current increases above the upper limit, the error message is generated.

### Probable Causes

- Defective leak sensor.
- Leak sensor incorrectly routed, being pinched by a metal component.

### Suggested Actions

✔ Exchange the leak sensor.

## Compensation Sensor Open

The ambient-compensation sensor (NTC) on the CSM board in the nano pump has failed (open circuit).

The resistance across the temperature compensation sensor (NTC) on the CSM board is dependent on ambient temperature. The change in resistance is used by the leak circuit to compensate for ambient temperature changes. If the resistance across the sensor increases above the upper limit, the error message is generated.

### Probable Causes

- Defective CSM board.

### Suggested Actions

✔ Exchange the CSM board.

## Compensation Sensor Short

The ambient-compensation sensor (NTC) on the CSM board in the nano pump has failed (short circuit).

The resistance across the temperature compensation sensor (NTC) on the CSM board is dependent on ambient temperature. The change in resistance is used by the leak circuit to compensate for ambient temperature changes. If the resistance across the sensor falls below the lower limit, the error message is generated.

### Probable Causes

- Defective CSM board.

### Suggested Actions

✔ Exchange the CSM board.

## Fan Failed

The cooling fan in the nano pump has failed. The hall sensor on the fan shaft is used by the CSM board to monitor the fan speed. If the fan speed falls below 2 revolutions/second for longer than 5 seconds, the error message is generated.

### Probable Causes

- Fan cable disconnected.
- Defective fan.
- Defective CSM board.
- Improperly positioned cables or wires obstructing fan blades.

### Suggested Actions

✔ Ensure the fan is connected correctly.

✔ Exchange fan.

✔ Exchange the CSM board.

✔ Ensure the fan is not mechanically blocked.

## Open Cover

The top foam has been removed.

The sensor on the CSM board detects when the top foam is in place. If the foam is removed, the fan is switched off, and the error message is generated.

### Probable Causes

- The top foam was removed during operation.
- Foam not activating the sensor.
- Sensor defective.
- Rear of the module is exposed to strong direct sunlight.

### Suggested Actions

✔ Replace the top foam.

✔ Exchange the CSM board.

✔ Ensure that the rear of the module is not exposed to strong sunlight.

## Restart Without Cover

The nano pump was restarted with the top cover and foam open.

The sensor on the CSM board detects when the top foam is in place. If the nano pump is restarted with the foam removed, the nano pump switches off within 30 s, and the error message is generated.

### Probable Causes

- The nano pump started with the top cover and foam removed.
- Rear of the module is exposed to strong direct sunlight.

### Suggested Actions

✔ Replace the top cover and foam.

✔ Ensure that the rear of the module is not exposed to strong sunlight.

## Zero Solvent Counter

Pump firmware version A.02.32 and higher allow to set solvent bottle fillings at the ChemStation (revision 5.xx and higher). If the volume level in the bottle falls below the specified value the error message appears when the feature is configured accordingly.

### Probable Causes

- Volume in bottle below specified volume.
- Incorrect setting of limit.

### Suggested Actions

✔ Refill bottles and reset solvent counters.

## Pressure Above Upper Limit

The system pressure has exceeded the upper pressure limit.

### Probable Causes

- Upper pressure limit set too low.
- Blockage in the flowpath (after the damper).
- Defective damper.
- Defective CSM board.

### Suggested Actions

✔ Ensure the upper pressure limit is set to a value suitable for the analysis.

✔ Check for blockage in the flowpath.

✔ Exchange the damper.

✔ Exchange the CSM board.

## Pressure Below Lower Limit

The system pressure has fallen below the lower pressure limit.

### Probable Causes

- Lower pressure limit set too high.
- Air bubbles in the mobile phase.
- Leak.
- Defective damper.
- Defective CSM board.

### Suggested Actions

✔ Ensure the lower pressure limit is set to a value suitable for the analysis.

✔ Ensure solvents are degassed. Purge the nano pump.

✔ Ensure solvent inlet filters are not blocked.

✔ Inspect the pump head, capillaries and fittings for signs of a leak.

✔ Purge the nano pump. Run a pressure test to determine whether the seals or other pump components are defective.

✔ Exchange the damper.

✔ Exchange the CSM board.

## Pressure Signal Missing

The pressure signal from the damper is missing.

The pressure signal from the damper must be within a specific voltage range. If the pressure signal is missing, the processor detects a voltage of approximately -120mV across the damper connector.

### Probable Causes

- Damper disconnected.
- Defective damper.

### Suggested Actions

✔ Ensure the damper is connected correctly to the CSM board.

✔ Exchange the damper.

## Valve Failed

**Valve 0 Failed:** valve A1

**Valve 1 Failed**: valve A2

**Valve 2 Failed**: valve B2

**Valve 3 Failed**: valve B1

One of the solvent selection valves in the nano pump failed to switch correctly.

The processor monitors the valve voltage before and after each switching cycle. If the voltages are outside expected limits, the error message is generated.

### Probable Causes

- Solvent selection valve disconnected.
- Connection cable (inside instrument) not connected.
- Connection cable (inside instrument) defective.
- Solvent selection valve defective.

### Suggested Actions

✔ Ensure the solvent selection valve is connected correctly.

✔ Ensure the connection cable is connected correctly.

✔ Exchange the connection cable.

✔ Exchange the solvent selection valve.

## Missing Pressure Reading

The pressure readings read by the pump ADC (analog-digital converter) are missing.

The ADC reads the pressure readings from the damper every 1ms. If the readings are missing for longer than 10 seconds, the error message is generated.

### Probable Causes

- Damper not connected.
- Defective damper.
- Defective CSM board.

### Suggested Actions

✔ Ensure the damper connector is clean, and seated correctly.

✔ Exchange the damper.

✔ Exchange the CSM board.

## Pump Configuration

At switch-on, the pump has recognized a new pump configuration.

The nano pump is assigned its configuration at the factory. If the active-inlet valve and pump encoder of channel B are disconnected, and the nano pump is rebooted, the error message is generated. *However, the* nano pump *will function as an isocratic pump in this configuration.*The error message reappears after each switch-on.

### Probable Causes

- Active-inlet valve and pump encoder of channel B disconnected.

### Suggested Actions

✔ Reconnect the active-inlet valve and pump encoder of channel B.

## Valve Fuse

**Valve Fuse 0:** Channels A1 and A2

**Valve Fuse 1:** Channels B1 and B2

One of the solvent-selection valves in the nano pump has drawn excessive current causing the selection-valve electronic fuse to open.

### Probable Causes

- Defective solvent selection valve.
- Defective connection cable (front panel to CSM board).
- Defective CSM board.

### Suggested Actions

✔ Restart the nano pump. If the error message appears again, exchange the solvent selection valve.

✔ Exchange the connection cable.

✔ Exchange the CSM board.

## Inlet-Valve Fuse

**Inlet-Valve Fuse 0:** Pump channel A

**Inlet-Valve Fuse 1:** Pump channel B

One of the active-inlet valves in the nano pump has drawn excessive current causing the inlet-valve electronic fuse to open.

### Probable Causes

- Defective active inlet valve.
- Defective connection cable (front panel to CSM board).
- Defective CSM board.

### Suggested Actions

✔ Restart the nano pump. If the error message appears again, exchange the active inlet valve.

✔ Exchange the connection cable.

✔ Exchange the CSM board.

## Temperature Out of Range

**Temperature Out of Range 0:** Pump channel A

**Temperature Out of Range 1:** Pump channel B

One of the temperature sensor readings in the motor-drive circuit are out of range.

The values supplied to the ADC by the hybrid sensors must be between 0.5 V and 4.3 V. If the values are outside this range, the error message is generated.

### Probable Causes

- Defective CSM board.

### Suggested Actions

✔ Exchange the CSM board.

## Temperature Limit Exceeded

**Temperature Limit Exceeded 0:** Pump channel A

**Temperature Limit Exceeded 1:** Pump channel B

The temperature of one of the motor-drive circuits is too high.

The processor continually monitors the temperature of the drive circuits on the CSM board. If excessive current is being drawn for long periods, the temperature of the circuits increase. If the temperature exceeds the upper limit of 95 ºC, the error message is generated.

### Probable Causes

- High friction (partial mechanical blockage) in the pump drive assembly.
- Partial blockage of the flowpath in front of the damper.
- Defective drive assembly.
- Defective CSM board.

### Suggested Actions

✔ Ensure the capillaries and frits between the pump head and damper inlet are free from blockage.

✔ Ensure the outlet valve is not blocked.

✔ Remove the pump head assembly. Ensure there is no mechanical blockage of the pump head assembly or pump drive assembly.

✔ Exchange defective drive assembly.

✔ Exchange the CSM board.

## Motor-Drive Power

**Motor-Drive Power:** Pump channel A

**B: Motor-Drive Power:** Pump channel B

The current drawn by the pump motor exceeded the maximum limit.

Blockages in the flowpath are usually detected by the pressure sensor in the damper, which result in the nano pump switching off when the upper pressure limit is exceeded. If a blockage occurs before the damper (i.e. the pressure increase cannot be detected by the pressure sensor), the nano pump will continue to pump. As pressure increases, the pump drive draws more current. When the current reaches the maximum limit, the nano pump is switched off, and the error message is generated.

### Probable Causes

- Flow path blockage in front of the damper.
- Blocked outlet ball valve.
- High friction (partial mechanical blockage) in the drive assembly.
- Defective drive assembly.
- Defective CSPM board.

### Suggested Actions

✔ Ensure the capillaries and frits between the pump head and damper inlet are free from blockage.

✔ Exchange the outlet ball valve.

✔ Remove the pump head assembly. Ensure there is no mechanical blockage of the pump head assembly or drive assembly.

✔ Exchange the drive assembly.

✔ Exchange the CSM board.

## Encoder Missing

**Encoder Missing:** Pump channel A

**B: Encoder Missing:** Pump channel B

The optical encoder on the pump motor in the nano pump is missing or defective.

The processor checks the presence of the pump encoder connector every 2 seconds. If the connector is not detected by the processor, the error message is generated.

### Probable Causes

- Defective or disconnected pump encoder connector.
- Defective pump drive assembly.

### Suggested Actions

✔ Ensure the connector is clean, and seated correctly.

✔ Exchange the pump drive assembly.

## Inlet-Valve Missing

**Inlet-Valve Missing:** Pump channel A

**B: Inlet-Valve Missing:** Pump channel B

The active-inlet valve in the nano pump is missing or defective.

The processor checks the presence of the active-inlet valve connector every 2 seconds. If the connector is not detected by the processor, the error message is generated.

### Probable Causes

- Disconnected or defective cable.
- Disconnected or defective connection cable (front panel to CSPM board).
- Defective active inlet valve.

### Suggested Actions

✔ Ensure the pins of the active inlet valve connector are not damaged. Ensure the connector is seated securely.

✔ Ensure the connection cable is seated correctly. Exchange the cable if defective.

✔ Exchange the active inlet valve.

## Electro-Magnetic-Proportional-Valve (EMPV) Missing

EMPV Missing

The EMPV in the micro pump is missing or defective.

### Probable Causes

- Disconnected or defective cable.
- Defective solenoid.

### Suggested Actions

✔ Ensure the connection cable is seated correctly.

✔ Exchange the solenoid of the EMPV.

## Flow sensor missing

### Probable Causes

- Flow sensor disconnected.
- Defective flow sensor.

### Suggested Actions

✔ Ensure the sensor is seated correctly.

✔ Exchange the flow sensor.

## Unsupported Flow Sensor

### Probable Causes

- A 20 µl/min or a 100 µl/min flow sensor is used with the nano pump.

### Suggested Actions

✔ Change to the nano flow sensor.

## Leak Sensor Missing

### Probable Causes

- Disconnected or defective cable.
- Defective leak sensor.

### Suggested Actions

✔ Ensure the connection cable is seated correctly.

✔ Exchange the leak sensor.

## Servo Restart Failed

**Servo Restart Failed:** Pump channel A

**B: Servo Restart Failed:** Pump channel B

The pump motor in the nano pump was unable to move into the correct position for restarting.

When the nano pump is switched on, the first step is to switch on the C phase of the variable reluctance motor. The rotor should move to one of the C positions. The C position is required for the servo to be able to take control of the phase sequencing with the commutator. If the rotor is unable to move, or if the C position cannot be reached, the error message is generated.

### Probable Causes

- Disconnected or defective cables.
- Mechanical blockage of the nano pump.
- Defective pump drive assembly.
- Defective CSM board.

### Suggested Actions

✔ Ensure the pump assembly cables are not damaged or dirty. Make sure the cables are connected securely to the CSM board.

✔ Remove the pump-head assembly. Ensure there is no mechanical blockage of the pump-head assembly or pump drive assembly.

✔ Exchange the pump drive assembly.

✔ Exchange the CSM board.

## Pump Head Missing

**Pump Head Missing:** Pump channel A

**B: Pump Head Missing:** Pump channel B

The pump-head end stop in the nano pump was not found.

When the nano pump restarts, the metering drive moves forward to the mechanical end stop. Normally, the end stop is reached within 20 seconds, indicated by an increase in motor current. If the end point is not found within 20 seconds, the error message is generated.

### Probable Causes

- Pump head not installed correctly (screws not secured, or pump head not seated correctly).
- Broken plunger.

### Suggested Actions

✔ Install the pump head correctly. Ensure nothing (e.g. capillary) is trapped between the pump head and body.

✔ Exchange the plunger.

## Index Limit

**Index Limit:** Pump channel A

**B: Index Limit:** Pump channel B

The time required by the plunger to reach the encoder index position was too short (nano pump).

During initialization, the first plunger is moved to the mechanical stop. After reaching the mechanical stop, the plunger reverses direction until the encoder index position is reached. If the index position is reached too fast, the error message is generated.

### Probable Causes

- Irregular or sticking drive movement.
- Defective pump drive assembly.

### Suggested Actions

✔ Remove the pump head, and examine the seals, plungers, and internal components for signs of wear, contamination or damage. Exchange components as required.

✔ Exchange the pump drive assembly.

## Index Adjustment

Index Adjustment: Pump channel A

B: Index Adjustment: Pump channel B

The encoder index position in the nano pump is out of adjustment.

During initialization, the first plunger is moved to the mechanical stop. After reaching the mechanical stop, the plunger reverses direction until the encoder index position is reached. If the time to reach the index position is too long, the error message is generated.

### Probable Causes

- Irregular or sticking drive movement.
- Defective pump drive assembly.

### Suggested Actions

✔ Remove the pump head, and examine the seals, plungers, and internal components for signs of wear, contamination or damage. Exchange components as required.

✔ Exchange the pump drive assembly.

## Index Missing

**Index Missing**: Pump channel A

**B: Index Missing**: Pump channel B

The encoder index position in the nano pump was not found during initialization.

During initialization, the first plunger is moved to the mechanical stop. After reaching the mechanical stop, the plunger reverses direction until the encoder index position is reached. If the index position is not recognized within a defined time, the error message is generated.

### Probable Causes

- Disconnected or defective encoder cable.
- Defective pump drive assembly.

### Suggested Actions

✔ Ensure the encoder cable are not damaged or dirty. Make sure the cables are connected securely to the CSM board.

✔ Exchange the pump drive assembly.

## Stroke Length

**Stroke Length**: Pump channel A

B: Stroke Length: Pump channel B

The distance between the lower plunger position and the upper mechanical stop is out of limits (nano pump).

During initialization, the nano pump monitors the drive current. If the plunger reaches the upper mechanical stop position before expected, the motor current increases as the nano pump attempts to drive the plunger beyond the mechanical stop. This current increase causes the error message to be generated.

### Probable Causes

- Defective pump drive assembly.

### Suggested Actions

✔ Exchange the pump drive assembly.

## Initialization Failed

Initialization Failed: Pump channel A

B: Initialization Failed: Pump channel B

The nano pump failed to initialize successfully within the maximum time window.

A maximum time is assigned for the complete pump-initialization cycle. If the time is exceeded before initialization is complete, the error message is generated.

### Probable Causes

- Blocked active inlet valve.
- Defective pump drive assembly.
- Defective CSM board.

### Suggested Actions

✔ Exchange the active inlet valve.

✔ Exchange the pump drive assembly.

✔ Exchange the CSM board.

## Wait Time-out

When running certain tests in the diagnostics mode or other special applications, the pump must wait for the plungers to reach a specific position, or must wait for a certain pressure or flow to be reached. Each action or state must be completed within the time-out period, otherwise the error message is generated.

### Possible Reasons for a Wait Time-out

- Pressure not reached.
- Pump channel A did not reach the delivery phase.
- Pump channel B did not reach the delivery phase.
- Pump channel A did not reach the take-in phase.
- Pump channel B did not reach the take-in phase.
- Solvent volume not delivered within the specified time.

### Probable Causes

- System still in purge mode.
- Leak at fittings, EMPV, active inlet valve, outlet ball valve or plunger seals.
- Flow changed after starting test.
- Defective pump drive assembly.

### Suggested Actions

✔ Ensure that purge valve is closed.

✔ Exchange defective capillaries.

✔ Ensure pump components are seated correctly. If there are still signs of a leak, exchange the appropriate seal (active inlet valve, outlet ball valve, plunger seal).

✔ Ensure correct operating condition for the special application in use.

✔ Exchange the defective pump drive assembly.

# Testing your Nano Pump

## Micro Mode Pressure Test

### Description

This is a fast test to verify the tightness of a micro system, where the pump is operating in the micro mode and no manual purge valve is installed. The flow path of the system which is tested for tightness is blocked by a blank nut. The pressure is increased up to 380 bar and the remaining flow is measured in the flow sensor while the system is blocked.

**Step 1** The test begins with the initialization of both pump heads. Next, pump A begins pumping solvent until a system pressure of 380 bar is reached.

**Step 2** The pump is operating in the pressure control mode at 380 bar for several minutes. The remaining flow in the column flow path between the EMPV and the blank nut is measured.

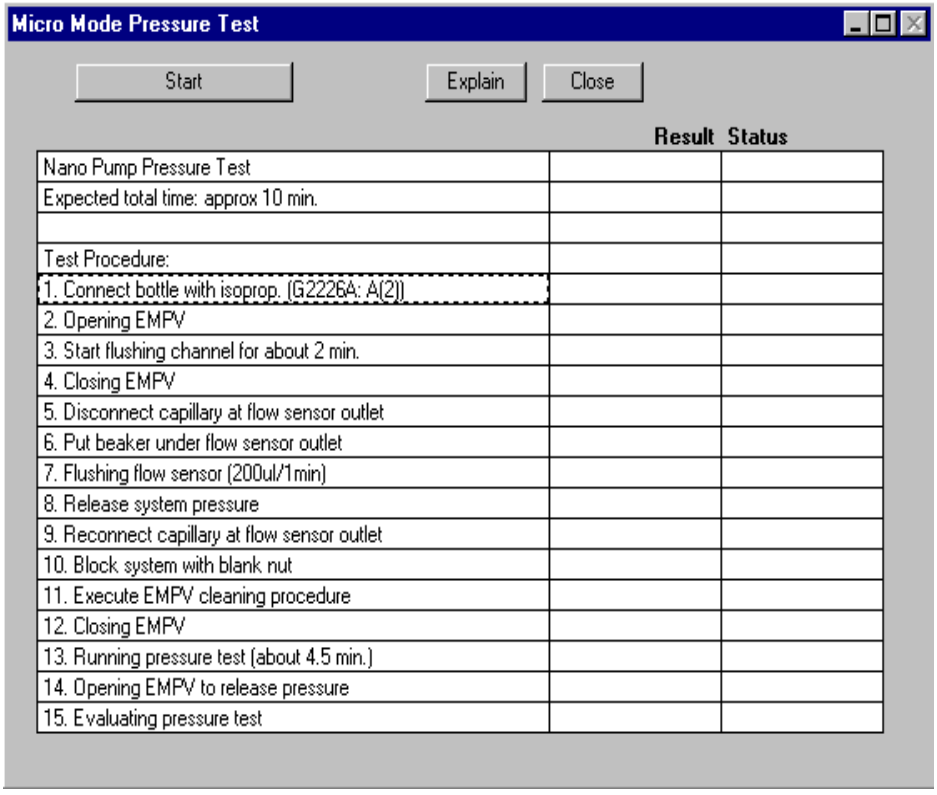
NOTE Make absolutely sure that all parts of the flow path that are included in the test are thoroughly flushed with IPA before starting to pressurize the system. Any trace of other solvents or the smallest air bubble inside the flow path will definitely cause the test to fail.

### Running the Test

1 Select the ChemStation's Diagnosis screen; from the nano pump tests selection box, select "Micro Mode Pressure Test".

2 Start the test and follow the online instructions

NOTE In step 10 of following procedure, if you block the flow sensor outlet use the PEEK blank nut provided in the accessory kit. Don't connect a SST blank nut to the flow sensor outlet, this could damage the flow sensor


Micro Mode Pressure Test
Start
Explain
Close
Result
Status
Nano Pump Pressure Test
Expected total time: approx 10 min.
Test Procedure:
1. Connect bottle with isoprop. (G2226A: A(2))
2. Opening EMPV
3. Start flushing channel for about 2 min.
4. Closing EMPV
5. Disconnect capillary at flow sensor outlet
6. Put beaker under flow sensor outlet
7. Flushing flow sensor (200ul/1min)
8. Release system pressure
9. Reconnect capillary at flow sensor outlet
10. Block system with blank nut
11. Execute EMPV cleaning procedure
12. Closing EMPV
13. Running pressure test (about 4.5 min.)
14. Opening EMPV to release pressure
15. Evaluating pressure test

### Micro Mode Pressure Test Results

The test results are evaluated automatically. The sum of all leaks within the column flow path from the EMPV to the blank nut must be lower than100 nl/min.

NOTE Small leaks, with no visible leaks in the flow path can cause the test to fail.

### If the pressure test fails

Ensure all fittings between the pump and the blank nut are tight and repeat the pressure test. If the test fails again, insert the blank nut at the outlet of the previous module in the stack, and repeat the pressure test. Exclude each module one by one to determine which module is leaky.

### Potential Causes of Pressure Test Failure

After isolating and fixing the cause of the leak, repeat the pressure test to confirm the system is tight.

| Potential Cause (Pump) | Corrective Action |
|---|---|
| Loose or leaky fitting. | Tighten the fitting or exchange the capillary. |
| Untight EMPV | Run the EMPV test |
| Damaged pump seals or plungers. | Run the leak test to confirm the leak. |
| High flow sensor offset | Run the flow sensor accuracy calibration and correct the flow sensor offset |

| Potential Cause (Autosampler) | Corrective Action |
|---|---|
| Loose or leaky fitting. | Tighten or exchange the fitting or capillary. |
| Needle seat. | Exchange the needle seat. |
| Rotor seal (injection valve). | Exchange the rotor seal. |
| Damaged metering seal or plunger. | Exchange the metering seal. Check the plunger for scratches. Exchange the plunger if required. |

## Normal Mode Pressure Test

### Description

The pressure test is a quick, built-in test designed to demonstrate the pressure-tightness of the system. The test should be used when problems with leaks are suspected, or after maintenance of flow-path components (e.g., pump seals, injection seal) to prove tightness up to 400 bar. The test involves monitoring the pressure profile as the nano pump runs through a predefined pumping sequence. The resulting pressure profile provides information about the pressure tightness of the system.

The injection device outlet (port 6) is blocked with a blank nut, and then the test is run using isopropyl alcohol (IPA), while monitoring the pressure profile (using an integrator on the analog output, or in the plot screen in the ChemStation). The pressure profile is shown in Figure 8.

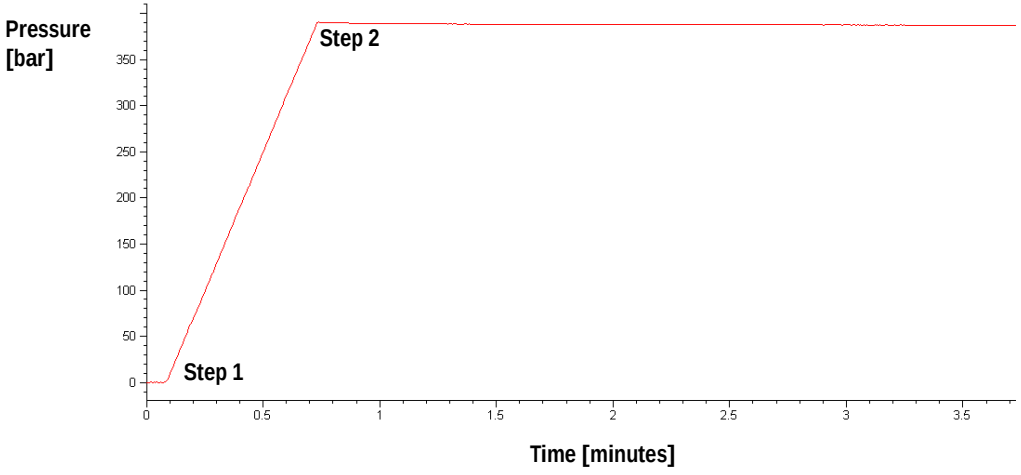



**Figure 8** Typical Pressure-Test Pressure Profile with IPA

**Step 1** The test begins with the initialization of both pumpheads. After initialization, plungers A1 and B1 are both at the top of their stroke. Next, pump A begins pumping solvent with a flow rate of 510 µl/min and stroke of 100 µl. The nano pump continues to pump until a system pressure of 390 bar is reached.

**Step 2** When the system pressure reaches 390 bar, the nano pump switches off. The pressure drop from this point onwards should be no more than 2 bar/minute.

NOTE For this test only channel A2 is active. To test the pressure tightness of the pump component use the leak test, see “Leak Test” on page 73.

**Positioning the blank nut** If a specific component is suspected of causing a system leak, place the blank nut immediately before the suspected component, then run the pressure test again.If the test passes, the defective component is located after the blank nut. Confirm the diagnosis by placing the blank nut immediately after the suspected component. The diagnosis is confirmed if the test fails.

### Running the Normal Mode Pressure Test

| | |
|---|---|
| **Tools required** | Wrench 1/4 inch. |
| **Parts and materials required** | Blank nut, 01080-83202<br>Isopropanol, 500 ml |

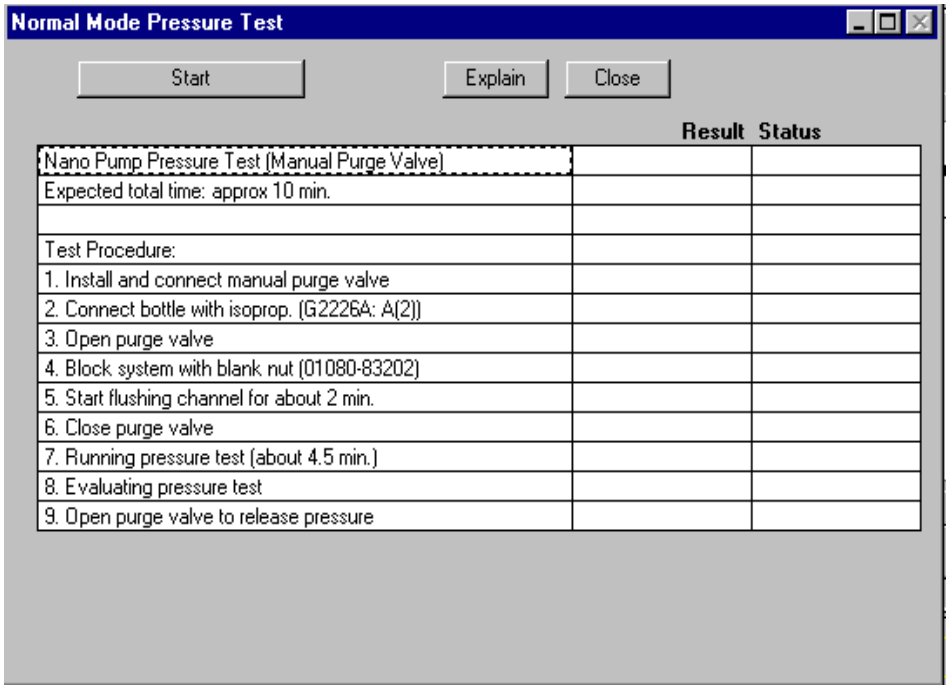
NOTE This test requires the manual purge valve installed and the Electronic Flow Control (EMPV and flow sensor) bypassed. To install the manual purge valve see "Installing the Manual Purge Valve" on page 114.

NOTE Make absolutely sure that all parts of the flow path that are part of the test are thoroughly flushed with IPA before starting to pressurize the system! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the test to fail!

### Running the test from the ChemStation

1 Select the pressure test from the test selection box in the Diagnosis screen.

2 Start the test and follow the instructions.


Normal Mode Pressure Test
Start
Explain
Close
Result
Status
Nano Pump Pressure Test (Manual Purge Valve)
Expected total time: approx 10 min.
Test Procedure:
1. Install and connect manual purge valve
2. Connect bottle with isoprop. (G2226A: A(2))
3. Open purge valve
4. Block system with blank nut (01080-83202)
5. Start flushing channel for about 2 min.
6. Close purge valve
7. Running pressure test (about 4.5 min.)
8. Evaluating pressure test
9. Open purge valve to release pressure

The slope and plateau is evaluated automatically. “Evaluating the Results” on page 71 describes the evaluation and interpretation of the pressure test results

### Running the test from the Control Module

1 Place a bottle of LC-grade isopropyl alcohol in the solvent cabinet and connect it to channel A2.

2 Block the injection device (port 6) with a blank nut (01080-83202), "Positioning the blank nut" on page 69

3 Set flow for channel A2 to 2500 µl/min and flush the degasser channel for about 5 minutes.

4 Set flow to 0 µl/min.

5 Connect the signal cable to the analog output at the rear of the nano pump (only if an integrator is used).

6 Press Execute to initialize the pressure test.

Once the test is started, the nano pump increase the pressure up to approximately 390 bar. Afterwards the flow stops and the pressure drop is monitored and displayed on the control module. The control module displays a graphical representation of the pressure. “Evaluating the Results” on page 71 describes the evaluation and interpretation of the pressure test results.

7 When the test is finished slowly unscrew the blank nut.

### Evaluating the Results

The sum of all leaks between the pump and the blank nut will be indicated by a pressure drop of >2 bar/minute at the plateau. Note that small leaks may cause the test to fail, but solvent may not be seen leaking from a module.

NOTE Please notice the difference between an ***error*** in the test and a ***failure*** of the test! An ***error*** means that during the operation of the test there was an abnormal termination. If a test ***failed***, this means that the results of the test where not within the specified limits.

### If the pressure test fails:

- Ensure all fittings between the pump and the blank nut are tight. Repeat the pressure test.

NOTE Often it is only a damaged blank nut itself (poorly shaped from overtightening) that causes a failure of the test. Before investigating on any other possible sources of failure make sure that the blank nut you are using is in good condition and properly tightened!

- If the test fails again, insert the blank nut at the outlet of the previous module in the stack and repeat the pressure test. Exclude each module one by one to determine which module is leaking.
- If the pump is determined to be the source of the leak, run the EMPV cleaning procedure, repeat the pressure test and if the test fails again, run the leak test.

### Potential Causes of Pressure Test Failure

After isolating and fixing the cause of the leak, repeat the pressure test to confirm the system is pressure tight.

| Potential Cause (Pump) | Corrective Action |
|---|---|
| Loose or leaky fitting. | Tighten the fitting or exchange the capillary. |
| Damaged pump seals or plungers. | Run the leak test to confirm the leak. |

| Potential Cause (Autosampler) | Corrective Action |
|---|---|
| Loose or leaky fitting. | Tighten or exchange the fitting or capillary. |
| Needle seat. | Exchange the needle seat. |
| Rotor seal (injection valve). | Exchange the rotor seal. |
| Damaged metering seal or plunger. | Exchange the metering seal. Check the plunger for scratches. Exchange the plunger if required. |

## Leak Test

The leak test is a built-in troubleshooting test designed to demonstrate the leak-tightness of the nano pump. The test should be used when problems with the nano pump are suspected. The test involves monitoring the pressure profile as the nano pump runs through a predefined pumping sequence. The resulting pressure profile provides information about the pressure tightness and operation of the nano pump components.

### Description

The pump outlet is blocked with a blank nut, and then the test is run using isopropyl alcohol (IPA), while monitoring the pressure profile (using an integrator on the analog output, or in the plot screen in the Control Module or the ChemStation). The pressure profile is shown in Figure 9.

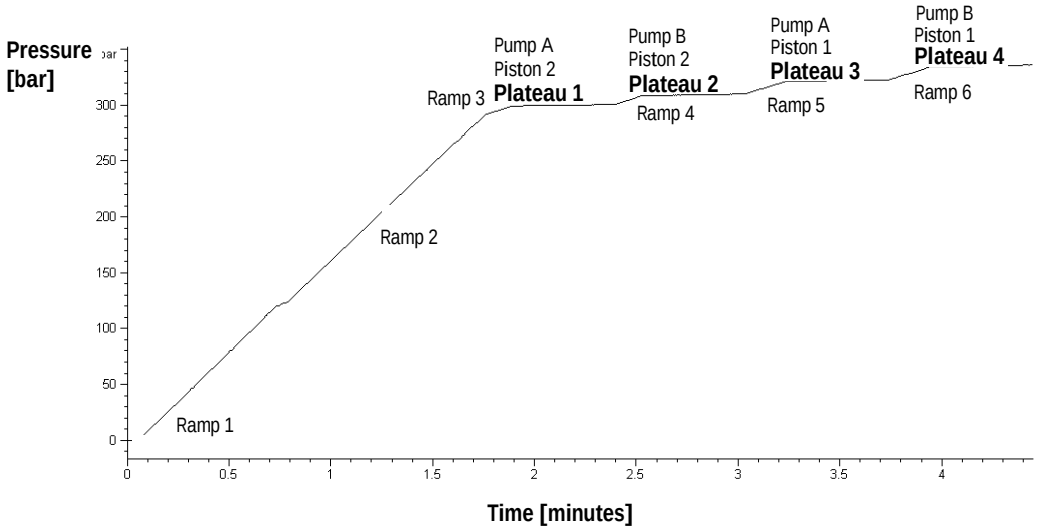



**Figure 9** Typical Leak-Test Pressure Profile with IPA

**Ramp 1** The test begins with the initialization of both pumps. After initialization, plungers A1 and B1 are both at the top of their stroke. Next, the nano pump begins pumping solvent with a flow rate of 150 µl/min, stroke of 100 µl, and a composition of 51 %A, 49 %B. Both pumps deliver for one complete pump cycle. At the end of this step, plungers A1 and B1 are at the top of their stroke.

**Ramp 2** The nano pump continues pumping solvent with a flow rate of 150 µl/min. Channel A delivers for one pump cycle (first, plunger A2 delivers, then plunger A1), followed by channel B (plunger B2, then plunger B1), both channels with a stroke of 20 µl. The pressure increase during this phase should be linear. Large leaks or defects will be characterized by an unstable, non-linear slope.

**Ramp 3** Just before the start of the first plateau, plunger A2 delivers with a flow rate of 50 µl/min for approximately 8 seconds. The system pressure should be 240 bar or higher.

**Plateau 1** At plateau 1 plunger A2 delivers with a flow rate of 3 µl/min for 30 seconds. During this time, the slope should be horizontal or slightly positive (slight pressure increase). A negative slope indicates a leak rate greater than 3 µl/min.

**Ramp 4** Plunger B2 delivers 50 µl/min for approximately 8 seconds.

**Plateau 2** Plunger B2 delivers with a flow rate of 3 µl/min for 30 seconds. The slope should be horizontal or slightly positive. A negative slope indicates a leak rate greater than 3 µl/min.

**Ramp 5** Plunger A1 delivers 50 µl/min for approximately 8 seconds.

**Plateau 3** Plunger A1 with a flow rate of 3 µl/min for 30 seconds. The slope should be horizontal or slightly positive. A negative slope indicates a leak rate greater than 3 µl/min.

**Ramp 6** Plunger B1 delivers 50 µl/min for approximately 7 seconds.

**Plateau 4** Plunger B1 delivers with a flow rate of 3 µl/min for approximately 30 seconds. The slope should be horizontal or slightly positive. A negative slope indicates a leak rate greater than 3 µl/min. At the end of the fourth plateau, the test is finished and the nano pump switches off.

### Running the Leak Test

| | |
|---|---|
| **Tools required** | Wrench 1/4 inch |
| **Parts and materials required** | Restriction Capillary,G1313-87305<br>Blank nut, 01080-83202<br>Isopropanol, 500ml |

NOTE Make absolutely sure that all parts of the flow path that are part of the test are very thoroughly flushed with IPA before starting to pressurize the system! Any trace of other solvents or the smallest air bubble inside the flow path definitely will cause the test to fail!

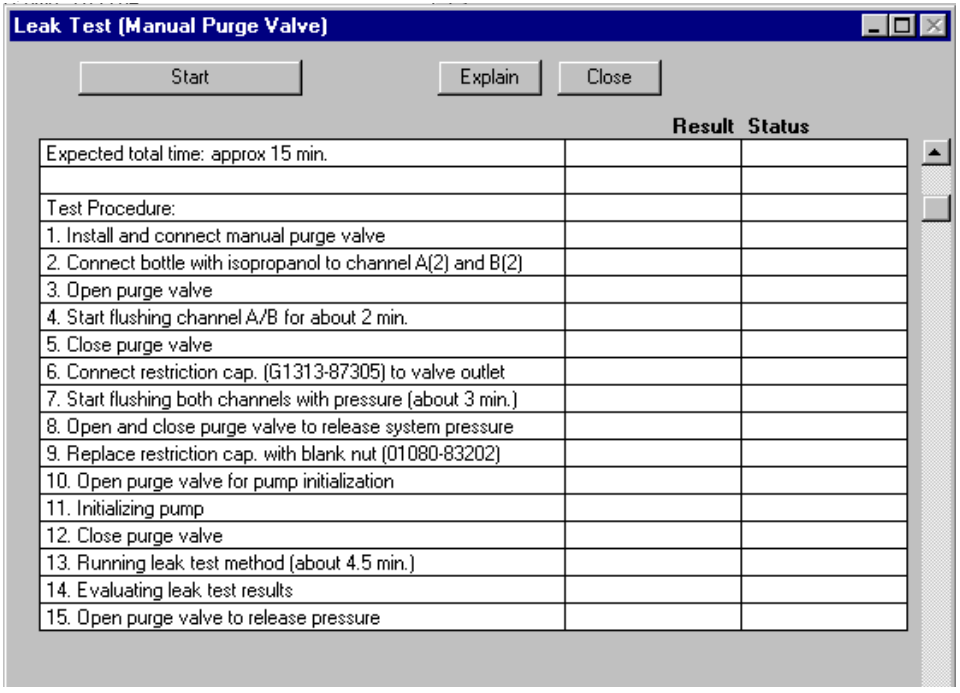
NOTE This test requires the manual purge valve installed and the Electronic Flow Control (EMPV and flow sensor) bypassed. To install the manual purge valve see "Installing the Manual Purge Valve" on page 114.

The slopes and plateaus are evaluated automatically. “Evaluating the Results of the Leak Test” on page 77 describes the evaluation and interpretation of the leak test results.

### Running the test from the ChemStation

1 Select the leak test from the test selection box in the Diagnosis screen.

2 Start the test and follow the instructions


Leak Test (Manual Purge Valve)
Start
Explain
Close
Result
Status
Expected total time: approx 15 min.
Test Procedure:
1. Install and connect manual purge valve
2. Connect bottle with isopropanol to channel A(2) and B(2)
3. Open purge valve
4. Start flushing channel A/B for about 2 min.
5. Close purge valve
6. Connect restriction cap. (G1313-87305) to valve outlet
7. Start flushing both channels with pressure (about 3 min.)
8. Open and close purge valve to release system pressure
9. Replace restriction cap. with blank nut (01080-83202)
10. Open purge valve for pump initialization
11. Initializing pump
12. Close purge valve
13. Running leak test method (about 4.5 min.)
14. Evaluating leak test results
15. Open purge valve to release pressure

### Running the test from the Control Module

1 Place two bottles of LC-grade isopropyl alcohol in channels A2 and B2.

2 Set flow to 2500 µl/min for channel A2 and B2 and flush the degasser for about 2 minutes.

NOTE If the pumps seals were replaced or the seals are not sufficient settled use the following procedure:

- Connect the restriction capillary (G1313-87305) to flow sensor outlet.
- Set flow to 2500 µl/min (normal mode) and 50 % B2.
- Pump for about 10 min.
- Stop the flow.

3 Set flow to 0 µl/min and replace the restriction capillary with blank nut (01080-83202).

4 Connect the signal cable to the analog output at the rear of the nano pump (only if an integrator is used).

5 Press Execute to initialize the leak test.

Once the test is started, the nano pump increase the pressure and run each plunger at low flow rate. The control module displays a graphical representation of the pressure in the plateau windows. “Evaluating the Results of the Leak Test” on page 77 describes the evaluation and interpretation of the leak test results.

6 When the test is finished slowly open the blank nut to release the pressure in the system.

### Evaluating the Results of the Leak Test

Defective or leaky components in the pump head lead to changes in the leak-test pressure plot. Typical failure modes are described below.

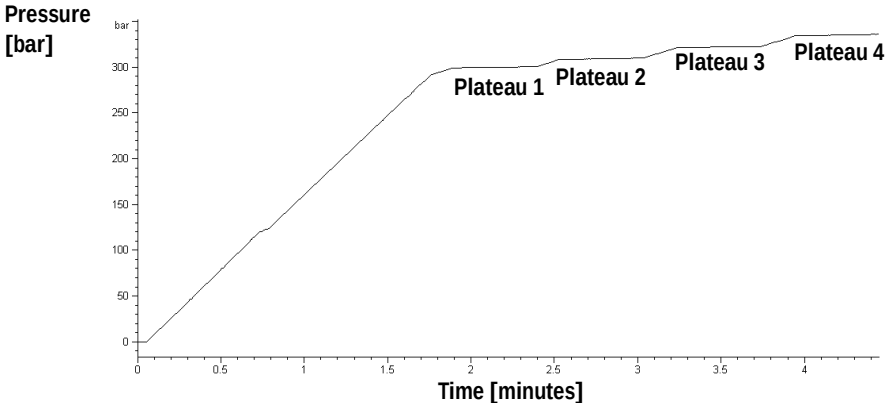



**Figure 10** Leak Test Pressure Plot

NOTE Please notice the difference between an ***error*** in the test and a ***failure*** of the test! An ***error*** means that during the operation of the test there was an abnormal termination. If a test ***failed***, this means that the results of the test where not within the specified limits.

NOTE Often it is only a damaged blank nut itself (poorly shaped from overtightening) that causes a failure of the test. Before investigating on any other possible sources of failure make sure that the blank nut you are using is in good condition and properly tightened!

NOTE The pressure plots shown below are examples only. The plots may vary depending on the type and degree of leakage.

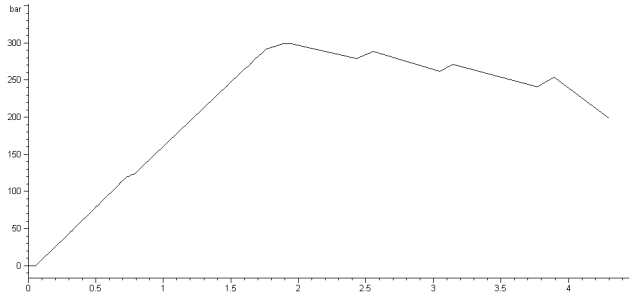
### No pressure increase or minimum pressure of plateau 1 not reached

| Potential Cause | Corrective Action |
|---|---|
| Pump not running. | Check the logbook for error messages. |
| Wrong solvent-line connections to solvent selection valve. | Ensure the solvent lines from the degasser to the solvent selection valve are connected correctly. |
| Loose or leaky fittings. | Ensure all fittings are tight, or exchange capillary. |
| Large leaks (visible) at the pump seals. | Exchange the pump seals. |
| Large leaks (visible) at active inlet valve, outlet valve. | Ensure the leaky components are installed tightly. Exchange the component if required. |

### Pressure limit not reached but plateaus horizontal or positive

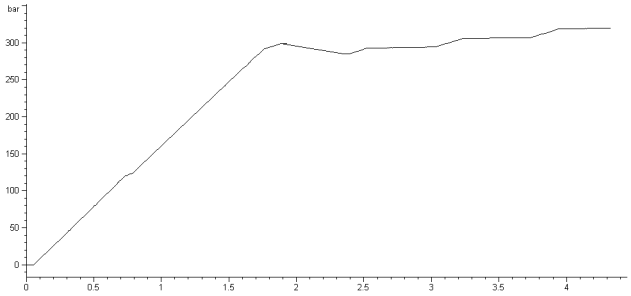
| Potential Cause | Corrective Action |
|---|---|
| Degasser and pump channels A and/or B not flushed sufficiently (air in the channels). | Purge the degasser and pump channels thoroughly with isopropanol under pressure (use the restriction capillary). |
| Wrong solvent. | Install isopropanol. Purge the degasser and pump channels thoroughly. |

## All plateaus negative



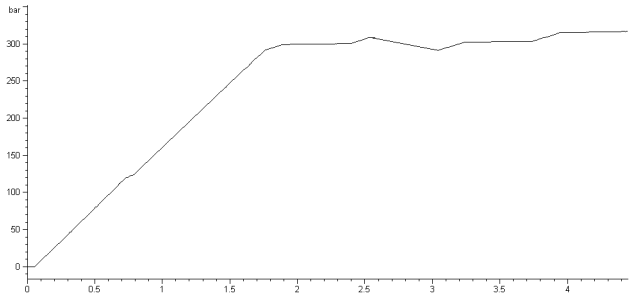

| Potential Cause | Corrective Action |
|---|---|
| Loose or leaky fittings. | Ensure all fittings are tight, or exchange capillary. |
| Leaky mixer (if installed). | Tighten the mixer fittings and nuts. |
| Loose pump head screws in channel A or B. | Ensure the pump head screws in channels A and B are tight. |
| Leaking seal or scratched plunger in channel A2 or B2. | Exchange the pump seals in both channels. Check the plungers for scratches. Exchange if scratched. |
| Leaking outlet valve in channel A or B. | Exchange the outlet valve. |
| Leaky damper. | Exchange damper. |

### First plateau negative or unstable, and at least one other plateau positive



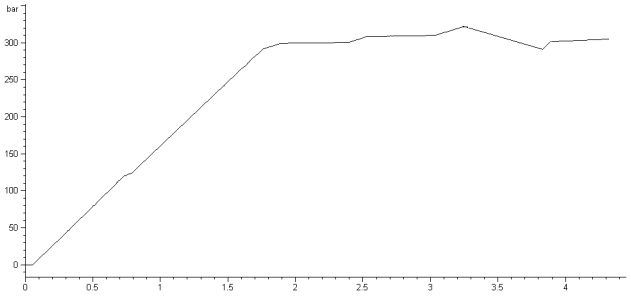

| Potential Cause | Corrective Action |
|---|---|
| Leaking outlet valve in channel A. | Clean the outlet valve in channel A. Ensure the sieve in the outlet valves are installed correctly. Tighten the outlet valve. |
| Loose pump head screws in channel A. | Ensure the pump head screws in channel A are tight. |
| Leaking seal or scratched plunger in channel A2. | Exchange the pump seals in channel A. Check the plunger for scratches. Exchange if scratched. |

### Second plateau negative or unstable, and at least one other plateau positive



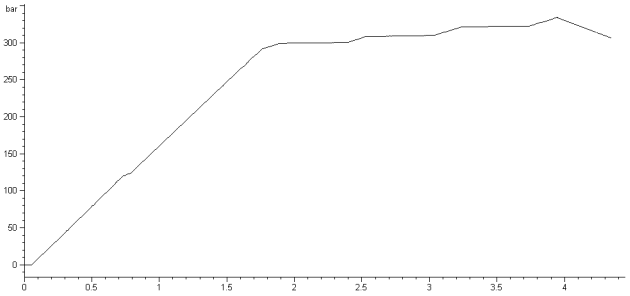

| Potential Cause | Corrective Action |
|---|---|
| Leaking outlet valve in channel B. | Clean the outlet valve in channel B. Ensure the sieve in the outlet valves are installed correctly. Tighten the outlet valve. |
| Loose pump head screws in channel B. | Ensure the pump head screws in channel B are tight. |
| Leaking seal or scratched plunger in channel B2. | Exchange the pump seals in channel B. Check the plunger for scratches. Exchange if scratched. |

### Third plateau negative or unstable and at least one other plateau positive




| Potential Cause | Corrective Action |
|---|---|
| Air in channel A or new seals not yet seated. | Flush channel A thoroughly with isopropanol under pressure (use restriction capillary). |
| Loose active inlet valve in channel A. | Tighten the active inlet valve in channel A (14mm wrench). Do not overtighten! |
| Loose pump head screws in channel A. | Ensure the pump head screws in channel A are tight. |
| Loose outlet valve in channel A. | Ensure the sieve in the outlet valve is installed correctly. Tighten the outlet valve. |
| Leaking seal or scratched plunger in channel A1. | Exchange the pump seals in channel A. Check the plungers for scratches. Exchange if scratched. |
| Defective active inlet valve in channel A. | Exchange the active inlet valve in channel A. |

## Fourth plateau negative or unstable and at least one other plateau positive




| Potential Cause | Corrective Action |
|---|---|
| Air in pump chamber of channel B or seals not yet seated. | Flush channel B thoroughly with isopropanol under pressure (restriction capillary). |
| Loose active inlet valve in channel B. | Tighten the active inlet valve in channel B (14mm wrench). Do not overtighten! |
| Loose pump head screws in channel B. | Ensure the pump head screws in channel B are tight. |
| Loose outlet valve in channel B. | Ensure the sieve in the outlet valve is installed correctly. Tighten the outlet valve. |
| Leaking seal or scratched plunger in channel B1. | Exchange the pump seals in channel B. Check the plungers for scratches. Exchange if scratched. |
| Defective active inlet valve in channel B. | Exchange the active inlet valve in channel B. |

## EMPV Test

### Description

The test is designed to verify the performance of the EMPV. The test must always be done when the EMPV valve is exchanged. The test should also be done if column flow stability problems occurs (micro mode only).

The EMPV test is not a substitute for the leak test or pressure test. The leak and pressure tests should also be done when leaks within the pump heads might be the problem.

**Step 1** The test starts with a short flushing sequence and a cleaning procedure for the EMPV.

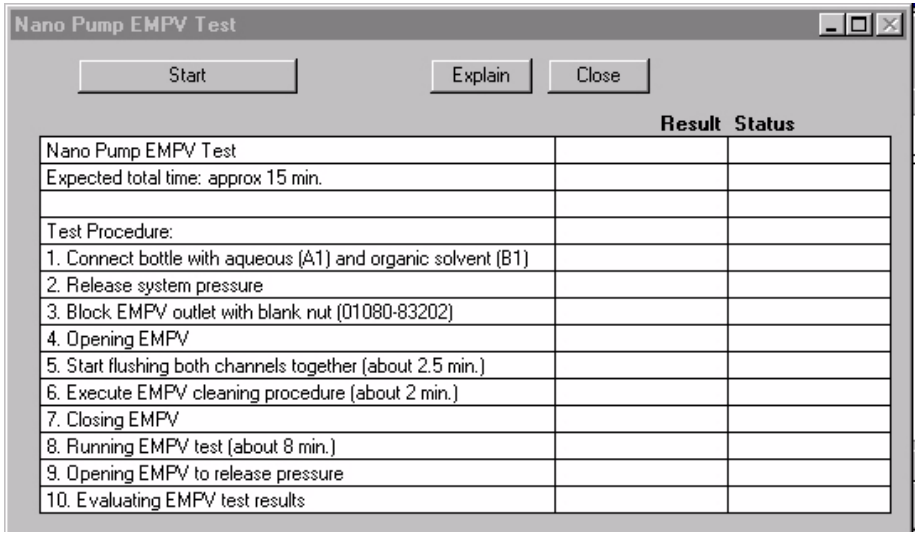
**Step 2** Afterwards, low and high pressure is controlled by the EMPV and the appropriate current is monitored.

**Step 3** Finally, a linear pressure ramp is performed.

### Running the test

1 Select the ChemStation's Diagnosis screen; from the nano pump tests selection box, select "Micro Mode Pressure Test".

2 Start the test and follow the online instructions


Nano Pump EMPV Test
Start
Explain
Close
Result
Status
Nano Pump EMPV Test
Expected total time: approx 15 min.
Test Procedure:
1. Connect bottle with aqueous (A1) and organic solvent (B1)
2. Release system pressure
3. Block EMPV outlet with blank nut (01080-83202)
4. Opening EMPV
5. Start flushing both channels together (about 2.5 min.)
6. Execute EMPV cleaning procedure (about 2 min.)
7. Closing EMPV
8. Running EMPV test (about 8 min.)
9. Opening EMPV to release pressure
10. Evaluating EMPV test results

## Evaluating the results

The test results are evaluated automatically.Two pressure plateaus are checked; one at 20 bar and the other at 300 bar. The appropriate current is measured. A further criterion is the difference between the two plateaus. The limits are as follows:

- < 85% EMPV current for the 20 bar plateau.
- > 15% EMPV current for the 300 bar plateau.
- > 15% difference between both EMPV current values.

## Flow Sensor Accuracy Calibration

### Description

The flow sensor accuracy calibration test is designed to calibrate the flow accuracy and to compensate the electronic offset of the nano flow sensor. This test should be done if high flow accuracy is needed at flow rates lower than 500 nl/min.

The calibration of the flow sensor is based in the linear relationship between the flow rate and pressure drop in a capillary. The zero point is corrected and calibration factors are evaluated.

**Step 1** The test begins with the initialization of the pump. After initialization, the EMPV is opening to release the pressure. No primary flow is delivered. After 2 minutes the flow sensor offset and pressure offset are measured.

**Step 2** The primary flow is set to 500 µl/min for 1 minute and the pressure drop over the inline filter is measured.

**Step 3** The pump is operating in the flow control mode and is delivering 2 µl/min for approximately 3 minutes. At the end of this step the pump is switched to pressure control mode. The actual pressure is the initial pressure.

**Step 4** The pump is delivering solvent for 3 minutes at a pressure equal to the initial pressure divided by 2. At the end of this step the corresponding flow sensor response is measured.

**Step 5** The pump is delivering solvent for 3 minutes at a pressure equal to the initial pressure divided by 4. At the end of this step the corresponding flow sensor response is measured.

**Step 6** The pump is delivering solvent for 2 minutes at a pressure equal to the initial pressure divided by 10. At the end of this step the corresponding flow sensor response is measured.

**Step 7** The pump is delivering solvent for 2 minutes at a pressure equal to the initial pressure divided by 20. At the end of this step the corresponding flow sensor response is measured.

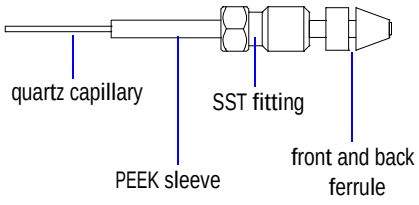
**Step 8** The EMPV is opening to release the pressure. No primary flow is delivered. After 2 minutes the flow sensor offset and pressure offset are measured.

NOTE Make absolutely sure that all parts of the flow path that are included in the test are very thoroughly flushed with WATER before starting to pressurize the system! Any trace of other solvents or the smallest air bubble inside the flow path will definitely cause the test to fail.

NOTE It is absolutely necessary that the pump is tight. We recommend to run the Micro Mode Pressure Test to verify the tightness of the pump

### Running the Test

1 Prepare the restriction capillary (G2226-67300)




2 Slide the PEEK sleeve over the fused silica capillary.

3 Slide the SST fitting over the PEEK sleeve.

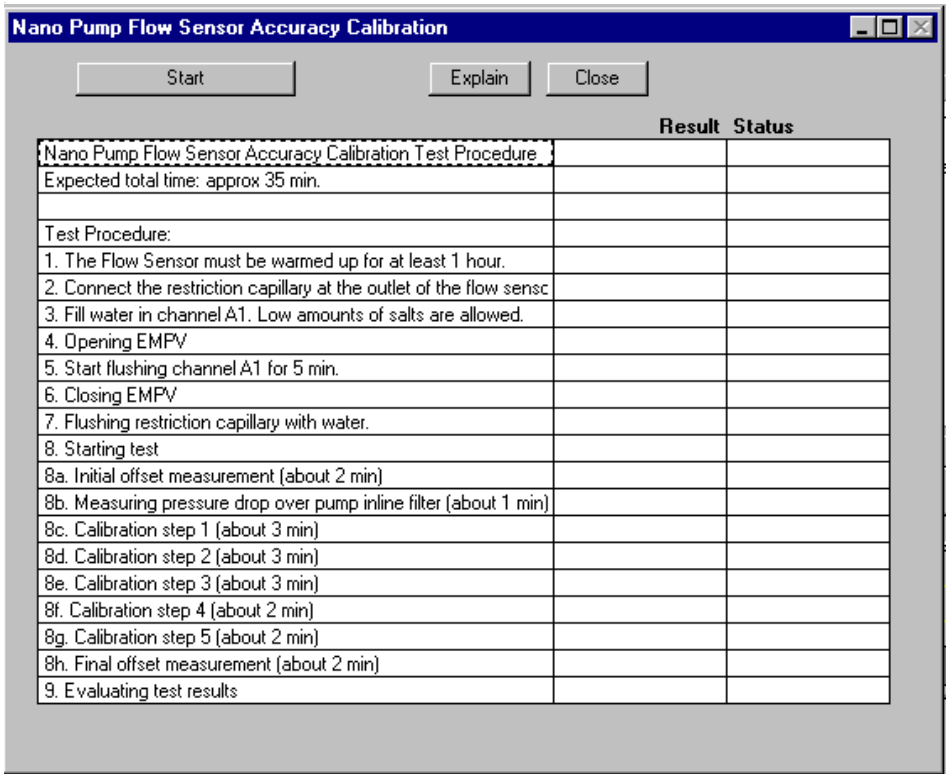
4 Slide the front and back ferrule over the PEEK sleeve.

5 Carefully press the capillary into an adjustment union and tight the fitting moderately with the 4 mm wrench (8710-1534) and the torque adapter (G1315-45003) to fix the ferrule.

NOTE To reach right values for the flow sensor accuracy calibration the restriction capillary G2226-67300 must not be damaged or blocked.

6 Select the ChemStation's Diagnosis screen; from the nano pump tests selection box, select "Flow Sensor Accuracy Calibration Test".

7 Start the test and follow the online instructions


Nano Pump Flow Sensor Accuracy Calibration
Start
Explain
Close
Result
Status
Nano Pump Flow Sensor Accuracy Calibration Test Procedure
Expected total time: approx 35 min.
Test Procedure:
1. The Flow Sensor must be warmed up for at least 1 hour.
2. Connect the restriction capillary at the outlet of the flow sensc
3. Fill water in channel A1. Low amounts of salts are allowed.
4. Opening EMPV
5. Start flushing channel A1 for 5 min.
6. Closing EMPV
7. Flushing restriction capillary with water.
8. Starting test
8a. Initial offset measurement (about 2 min)
8b. Measuring pressure drop over pump inline filter (about 1 min)
8c. Calibration step 1 (about 3 min)
8d. Calibration step 2 (about 3 min)
8e. Calibration step 3 (about 3 min)
8f. Calibration step 4 (about 2 min)
8g. Calibration step 5 (about 2 min)
8h. Final offset measurement (about 2 min)
9. Evaluating test results

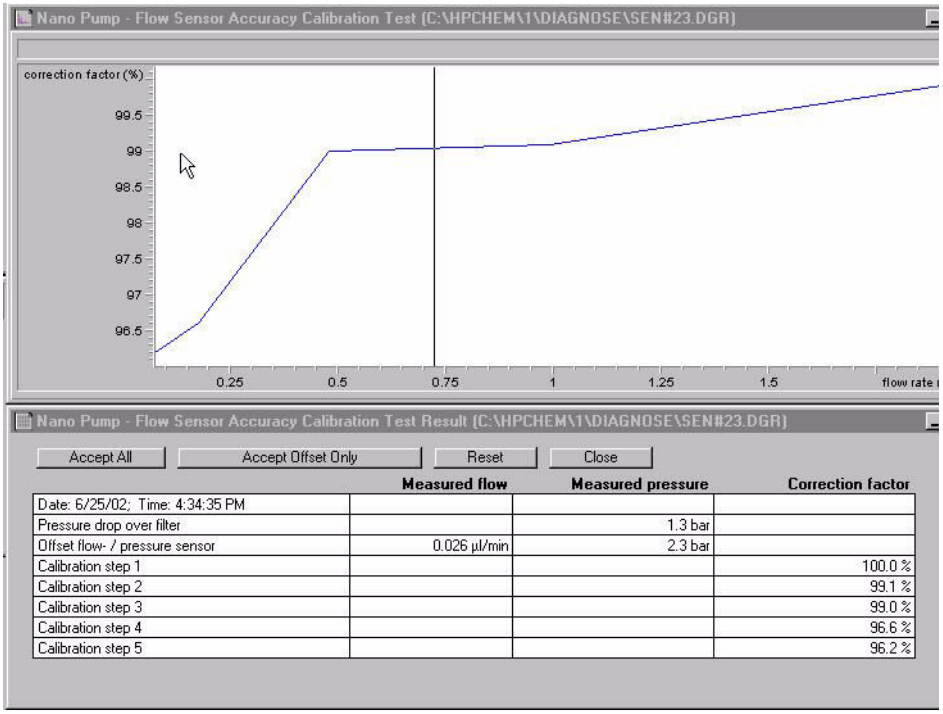
**8** The test results are evaluated automatically.

### Test results

In the ChemStation, the measured values are evaluated automatically. A table with the measured pressure drop over the inlet filter, the measured flow and pressure offset and the correction factors for all steps are printed.

You have now the possibility to: accept and store all the correction factors and the measured offset, accept only the measured offset, reset (no correction factor or offset are applied).

### Test evaluation




| | Measured flow | Measured pressure | Correction factor |
|---|---|---|---|
| Date: 6/25/02; Time: 4:34:35 PM | | | |
| Pressure drop over filter | | 1.3 bar | |
| Offset flow- / pressure sensor | 0.026 µl/min | 2.3 bar | |
| Calibration step 1 | | | 100.0 % |
| Calibration step 2 | | | 99.1 % |
| Calibration step 3 | | | 99.0 % |
| Calibration step 4 | | | 96.6 % |
| Calibration step 5 | | | 96.2 % |

**Figure 11** Flow sensor accuracy calibration test evaluation

**Table 5** Flow sensor accuracy calibration test evaluation

| | | |
|---|---|---|
| **Pressure drop over filter** | The measured value should not be higher than 10 Bar | If higher we recommend to change the filter in front of the EMPV and restart the test again. |
| **Offset flow** | This value can be positive or negative* and should be between 500 nL/min and -90 nL/min. | If higher or lower replace the nano flow sensor. |
| **Offset pressure sensor** | This value has not to be considered in the evaluation. | |

**Table 5** Flow sensor accuracy calibration test evaluation, continued

| | | |
|---|---|---|
| **Correction factor** | • Step 1: Between 95 % and 105 %<br>• Step 5: Between 80 % and 500 %<br>• Step 2-4: Continuous trend between Step 1 and Step 5. | • If value out of range check the restriction capillary for damage or blockage and repeat the test.<br>• If value still out of range, accept the “offset only” at the end of the test†. |

*** If the flow sensor has a negative offset the minimum flow rate the pump can operate is the numeric value of the measured offset. For example: If offset flow is 0.030 µL / min. the minimum flow rate the pump can operate is 30 nL / min.**

† **The offset of the nano flow sensor has a more significant influence on the flow sensor accuracy than the linearity.**

# EMPV Cleaning

## Description

Depending on the application, sometimes particles can be collected in the EMPV valve. This fast cleaning routine is designed to remove such particle deposits. The routine should always be performed when the EMPV is suspected of being leaky, or contaminated with particles.

**Step 1** The outlet of the EMPV is plugged with a blank nut. After a short flushing routine, the EMPV is closed and the pressure is increased to approximately 380 bar.

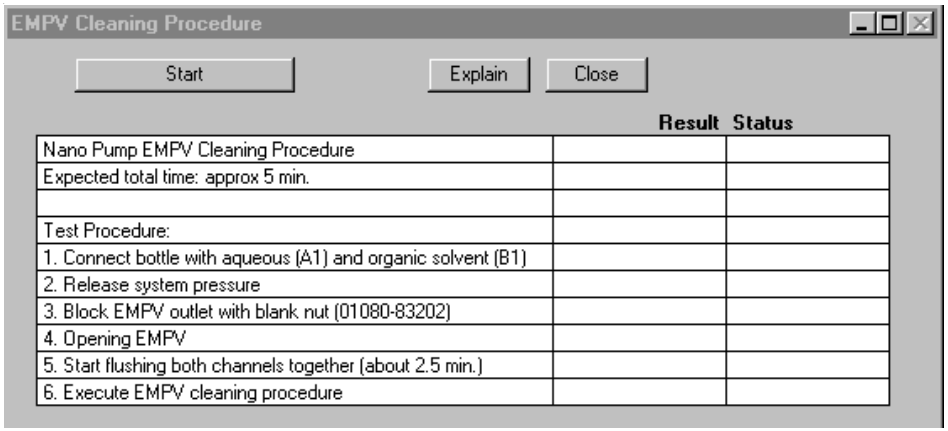
**Step 2** The EMPV is then opened and the pressure is released very quickly.

**Step 3** This procedure is repeated several times in a sequence.

## Running the Cleaning procedure

1 Select the ChemStation Diagnosis screen, from the maintenance selection box, select “EMPV Cleaning”.

2 Start the test and follow the online instructions


EMPV Cleaning Procedure
Start
Explain
Close
Result
Status
Nano Pump EMPV Cleaning Procedure
Expected total time: approx 5 min.
Test Procedure:
1. Connect bottle with aqueous (A1) and organic solvent (B1)
2. Release system pressure
3. Block EMPV outlet with blank nut (01080-83202)
4. Opening EMPV
5. Start flushing both channels together (about 2.5 min.)
6. Execute EMPV cleaning procedure

# Basic System Troubleshooting

In this troubleshooting guide, you will find a Possible Causes/Suggested Actions approach to troubleshooting and correcting certain capillary LC system problems.

The problems are categorized by the following symptoms:

System Pressure Abnormally Low 93
System Pressure Abnormally High 94
EMPV failed to initialize (micro mode only) 95
Unstable column flow and/or system pressure 96
Poor peak shape 98
Failure to produce peaks, or abnormally small peaks, after injection 99
Wandering Detector Baseline 100
User interface displays error messages for specific modules 101

NOTE This troubleshooting guide deals with systemic problems of the capillary LC. For detailed diagnostic, troubleshooting and repair information on specific LC modules (status indicators, error messages, diagnostic tests, etc.), refer to the Reference Manual supplied with the specific LC module.

## System Pressure Abnormally Low

The current system pressure is significantly below the typical system pressure produced by this method with this column.

**Table 6** System Pressure Abnormally Low: Possible causes and actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **Leaks somewhere in the system** | • Use a flashlight and absorbent tissue to search for leaks throughout the system. | At very low flow rates, a leak may never accumulate enough liquid to trigger the module leak sensors. Low flow rate leaks are also very hard to see. |
| **Solvent channels are not correctly purged. %Ripple might also be too high** | • Perform a 4-minute purge at 2500 µl/min for each solvent channel. | This is especially likely if the system has been unused for more than one day. |
| **Dirty solvent inlet filters Solvent intake is being restricted, %Ripple might also be too high** | • Clean or replace the solvent inlet filters. | To minimize this problem, prefilter the mobile phase, and take precautions against algae formation in the water. |

## System Pressure Abnormally High

The current system pressure is significantly above the typical system pressure produced by this method with this column.

**Table 7** System Pressure Abnormally High: Possible causes and actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **The analytical column has become plugged** | • Replace the column. Otherwise, backflush the column or replace the column inlet frit. | |
| **The filter in front (upstream) of the EMPV has become plugged** | • Perform a pump purge at 1000 µl/min using pure water. During the purge, check system pressure. If pressure is >10 bar, replace the EMPV filter. | I |
| **A component in the micro-sampler has become plugged. This could be the sample loop, needle, needle seat assembly or injection valve ports.** | • Using the sampler maintenance positions, switch the sampler injection valve from mainpass to bypass. If pressure is significantly reduced:<br>• Backflush or change the needle seat assembly.<br>• Replace the needle.<br>• Backflush or replace the sample loop capillary.<br>• Replace the injection valve rotor seal.<br>• Clean the stator head with acetone, and make sure the stator head ports are free of particles. | For severe capillary tube plugs, acetone is a good backflushing solvent. |
| **A capillary before or after the sampler in the system has become plugged, broken, crushed by a module cover or overtightened.** | • Refer to the system flow diagram. One at a time, disconnect the capillaries in the following order. When the defective capillary is found, it may be backflushed with acetone, or replaced.<br>• EMPV-to-flow sensor capillary<br>• flow sensor-to-sampler injection valve capillary<br>• sampler injection valve-to-column inlet capillary<br>• flow cell assembly (includes inlet and outlet capillaries) | |

## EMPV failed to initialize (micro mode only)

An attempt to pump in the micro mode has resulted in either an EMPV Initialization Failed error message, or a permanent EMPV Initialization not ready message.

NOTE Make sure the system pressure is higher than 20 bar.

**Table 8** EMPV failed to initialize: Possible Causes and Suggested Actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **The no-flow pressure of the system is higher than 10 bar.** | • Set the flow to zero, and disconnect the blue flexible capillary going from the damper to the mixer The system pressure reading should be close to zero bar.<br>• If the system pressure reading is higher than 4 bar, call Agilent service, or refer to the Nano Pump Service Manual. | This problem typically causes a permanent EMPV Initialization not ready message. |
| **The inlet to the EMPV has been blocked, or partially restricted. The EMPV cannot take in sufficient flow to deliver the correct flow output. The EMPV initialization routine cannot be done within the required 2-minute period.** | • Make sure the solvent channels are well purged.<br>• Check the EMPV filter. Perform a pump purge at 1000 µl/min using pure water. During the purge, check system pressure. If pressure is >10 bar, replace the filter in front of the EMPV.<br>• Check the flow path from the damper outlet to the EMPV inlet for plugs or restrictions.<br>• Check the EMPV-to-flow sensor capillary for a total plug or partial restriction. Replace the capillary, or backflush the capillary with acetone.<br>• Replace the EMPV assembly (G1361-60000). Call Agilent service or refer to the Nano Pump Service Manual "Exchanging the EMPV Assembly" on page 117. | This problem typically causes an EMPV Initialization Failed error message |

## Unstable column flow and / or system pressure

In the micro mode, the pump flow control system is active. The flow control system continuously measures the actual value of column flow, and maintains the requested column flow despite changes in system restriction. If the flow control becomes defective, actual column flow, hence system pressure, will fluctuate. If the system offers a changing restriction to the pump, actual column flow will fluctuate as the pump tries to maintain flow against the changing restriction. Therefore, in the micro mode, unstable column flow and unstable system pressure usually appear together.

**Table 9** Unstable column flow and / or system pressure: Possible Causes and Suggested Actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **The flow setpoint is below the recommended minimum value.** | • Make sure that the column flow setpoint is above the recommended minimum setpoint: | Normal mode 100 µl / min<br>Micro mode, 20 µl flow sensor 1 µl / min<br>Micro mode, 100 µl flow sensor 10 µl / min |
| **The system pressure is insufficient for reliable flow control (micro mode).** | • Make sure that there is at least 20 bar pressure being developed after the pump.<br>• Add an additional capillary after the pump if required. | |
| **Leaks somewhere in the system.** | • Use a flashlight and absorbent tissue to search for leaks throughout the system. Check for leaks after the pump, and inside the pump (valves, fittings, etc.)<br>• If operating in the micro mode, perform the micro mode pressure test. If operating in the normal mode, perform the normal mode pressure test. | At very low flow rates, a leak may never accumulate enough liquid to trigger the module leak sensors. Low flow rate leaks are also very hard to see.<br>Refer to the Nano Pump Service Manual "Testing your Nano Pump" on page 65, "Normal Mode Pressure Test" on page 68. |
| **One or more solvent channels are not correctly purged. %Ripple might also be too high.** | • Perform a 2-minute purge at 2500 µl / min for each solvent channel. | This is especially likely if the system has been unused for more than one day. |
| **Dirty solvent inlet filters. Solvent intake is being restricted. %Ripple might also be too high.** | • Temporarily remove solvent inlet filters to see if they are the cause of the problem. If so, clean or replace the solvent inlet filters. | To minimize this problem, prefilter the mobile phase, and take precautions against algae formation in the water. |

**Table 9** Unstable column flow and/or system pressure: Possible Causes and Suggested Actions, continued

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **Dirty EMPV (micro mode only)** | • Perform the EMPV cleaning procedure, followed by the EMPV performance test. Refer to the Nano Pump Service Manual "EMPV Cleaning" on page 91. | |
| **One of a capillary after the EMPV is partially or completely blocked** | • Remove the blocked capillary, clean it with Acetone<br>• Change the capillary | |
| **Any system component which is offering a changing restriction to the pump.** | • Replace the analytical column.<br>• Replace the filter frit in front (upstream) of the EMPV. | |
| **The vacuum micro-degasser is off, or has become defective.** | • Try another vacuum micro-degasser, or experiment to determine the performance using different degasser channels.<br>• If the mobile phase is very sensitive to gaseousness, use the micro-degasser continuous mode. | |
| **Basic performance problems in the pump.** | • Perform the pump Leak Test. | Refer to the Nano Pump Service Manual "Leak Test" on page 73. |

## Poor peak shape

The peak shape has taken on a fronting or tailing characteristic.

**Table 10** Poor peak shape: Possible Causes and Suggested Actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **Column performance has deteriorated** | • Try a new column | |
| **Poorly made capillary connections, causing excessive dead volume or leaks in a chromatographically significant area of the system** | • Using a flashlight and absorbent tissue, carefully check for leaks throughout the system, especially in the following areas:<br>**a** All micro-sampler valve ports.<br>**b** Column inlet and outlet.<br>**c** Flow cell inlet capillary, at the capillary/cell body junction.<br>• Refer to chapter 3 for information on connecting capillaries. Make sure the capillary connections are correctly made throughout the system, especially in the following areas:<br>**a** All micro-sampler valve ports.<br>**b** Column inlet and outlet.<br>**c** Flow cell inlet capillary, at the capillary/cell body junction. | At very low flow rates, a leak may never accumulate enough liquid to trigger the module leak sensors. Low flow rate leaks are also very hard to see. |
| **Capillaries which are internally broken, especially those capillaries located in a chromatographically significant area.** | • Refer to chapter 3 for advice on diagnosing an internally broken capillary. Check capillaries for an internal break, particularly the needle-seat capillary, the sampler valve-to-column capillary and the flow cell inlet capillary. | Capillaries which have been crushed by module covers are often broken internally, and may show no external evidence of a break. |

## Failure to produce peaks, or abnormally small peaks, after injection

There are no peaks, or the peak size is significantly below the typical peak size for this method with this column.

**Table 11** Failure to produce peaks, or abnormally small peaks, after injection: Possible Causes and Suggested Actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **A leak in a sample carrying area of the system.** | • Using a flashlight and absorbent tissue, carefully check for leaks in the following areas:<br>a. All micro-sampler valve ports.<br>b. The junction of the needle and sample loop capillary.<br>c. The needle/seat interface.<br>d. Column inlet and outlet.<br>e. Flow cell inlet capillary, at the capillary/cell body junction. | At very low flow rates, a leak may never accumulate enough liquid to trigger the module leak sensors. Low flow rate leaks are also very hard to see. |
| **The 40 µl chamber of the micro-sampler metering head has developed bubbles.** | • In the user interface diagnostics, access the **Change Piston** function of the micro-sampler maintenance positions. This function draws the metering piston fully inward, clearing the chamber.<br>• Under flow conditions, activate this function for at least 5 minutes. The sampler valve must be in the mainpass position at this time. Any bubbles which have formed in the chamber will now be cleared by the flow. | In most applications, only a small part of the available 40µl metering head volume is used. At very low flows, bubbles may form in the unused space between the metering piston and the chamber wall. The bubbles act to defeat the draw of sample into the needle.<br>For best results in clearing bubbles, the mobile phase being pumped should not contain water. |

## Wandering Detector Baseline

### Critical Decision

Determine if the problem is in the DAD, or coming from the LC system:

Remove the flow cell from the DAD. Close the cell cover, and see if the baseline performance improves.

1 If baseline performance has not improved:

   a Replace the lamp(s).

   b Evaluate the environment for excessive drafts, temperature changes, etc.

2 If baseline performance has improved, focus attention on the possible causes and suggested actions below.

**Table 12** Wandering Detector Baseline Possible Causes and Suggested Actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **Dirty or defective flow cell** | • Clean or replace the flow cell | |
| **The analytical column** | • Bypass the column. Pump directly into the flow cell. If performance improves, try a new column. | |
| **"Mixing Noise" when pumping a binary mobile phase from two channels.** | • Try premixing the mobile phase in one bottle, and pumping 100% from that one solvent channel.<br>If baseline performance improves, a solution must be found which is a compromise between mixing volume and other chromatographic requirements. For an isocratic analysis, premixing and pumping 100% one channel is the best solution. | This problem occurs when one (or both) of the solvents has a high background absorbance at the detection wavelength. In this case, the pump's mixing efficiency may not be good enough to produce a sufficiently homogeneous mobile phase.<br>The detector reacts to gluts of the more detectable parts of the solvent mixture, and baseline disturbances result. |
| **Unstable flow and / or system pressure.** | • Refer to the problem Unstable flow and / or system pressure above. If your system suffers from this problem, go through the possible causes and suggested actions described there. | Failure to maintain stable column flow or system pressure can also cause unwanted baseline activity. |

## User interface displays error messages for specific modules

**Table 13** User interface displays error messages for specific modules: Possible causes and suggested actions

| Possible Causes | Suggested Actions | Notes |
|---|---|---|
| **A module has experienced a specific hardware failure during operation** | • Refer to the Reference Manual supplied with the module. Follow the advice on troubleshooting and repair for the error message displayed. | A specific error message for that module is displayed.<br>The status indicator of that module is red. |

# 3 Repairing the Pump

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Using the ESD Strap 106

**Overview about the Nano Pump 107**
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Exchanging the Leak Sensor 149

Exchanging Status Light Pipe 152
Assembling the Main Cover 153
Replacing the Top Cover and Foam 154

This chapter includes Instruction on how to repair the pump.

# Introduction

## Simple Replacements

The nano pump is designed for easy repair. The most frequent repairs such as plunger seal change and filter frit change can be done with the nano pump in place in the system stack. These repairs are described in “Simple Repair Procedures” on page 108.

**WARNING** **When opening capillary or tube fittings solvents may leak out. Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

## Exchanging Internal Parts

Some repairs may require exchange of defective internal parts. Exchange of these parts requires removing the nano pump from the stack, removing the covers, and disassembling the nano pump. The security lever at the power input socket prevents that the pump cover is taken off when line power is still connected.

**WARNING** **To prevent personal injury, the power cable must be removed from the nano pump before opening the cover. Do not connect the power cable to the nano pump while the covers are removed.**

**CAUTION** Electronic boards and components are sensitive to electrostatic discharge (ESD). In order to prevent damage always use an ESD protection (for example, the ESD wrist strap from the accessory kit) when handling electronic boards and components.

## Cleaning the Nano Pump

The nano pump case should be kept clean. Cleaning should be done with a soft cloth slightly dampened with water or a solution of water and a mild detergent. Do not use an excessively damp cloth as liquid can drop into the nano pump.

**WARNING** **Do not let liquid drip into the nano pump. It could cause shock hazard and it could damage the nano pump.**

## Using the ESD Strap

Electronic boards are sensitive to electrostatic discharge (ESD). In order to prevent damage, always use an ESD strap supplied in the standard accessory kit (see “Nano Pump Accessory Kit G2226-68705” on page 172) when handling electronic boards and components.

### Using the ESD Strap

1. Unwrap the first two folds of the band and wrap the exposed adhesive side firmly around your wrist.
2. Unroll the rest of the band and peel the liner from the copper foil at the opposite end.
3. Attach the copper foil to a convenient and exposed electrical ground.

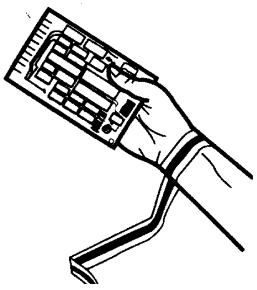


**Figure 12** Using the ESD Strap

# Overview about the Nano Pump

Figure 13 shows the main assemblies of the nano pump. The pump heads and its parts do require normal maintenance (for example, seal exchange) and can be accessed from the front (simple repairs). Replacing internal parts will require removing the module from its stack and to open the top cover.

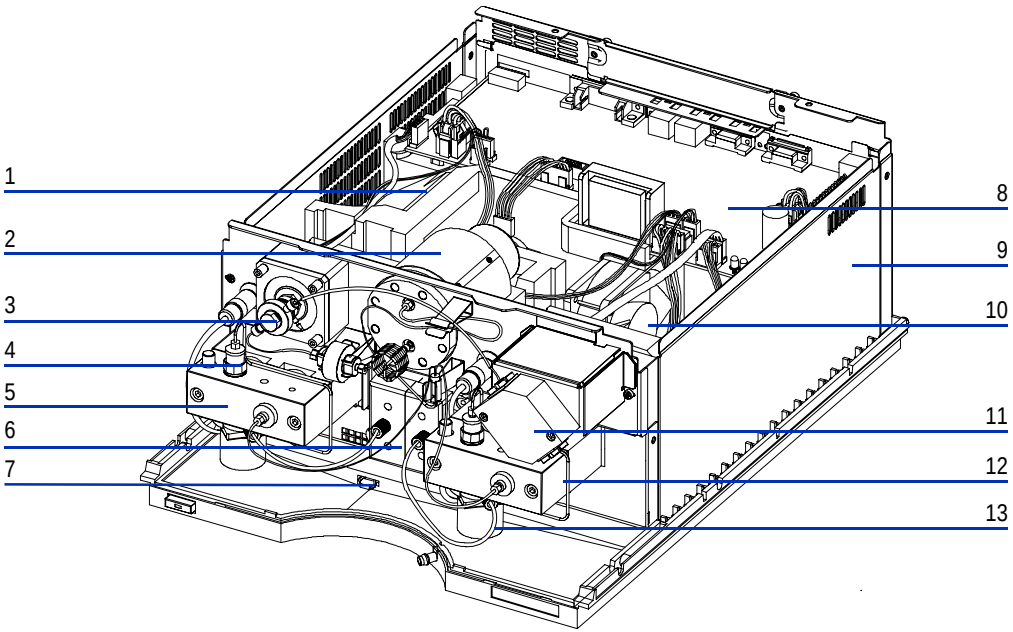



**Figure 13** Overview of Repair Procedures

| | | | |
|---|---|---|---|
| 1 | Pumpdrive A | 8 | Main Board |
| 2 | Damper | 9 | Power Supply |
| 3 | EMPV | 10 | Fan |
| 4 | Outlet Ball Valve A | 11 | Flow Sensor |
| 5 | Pumphead A | 12 | Pumphead B |
| 6 | Solvent Selection Valve | 13 | Active Inlet Valve B |
| 7 | Leak Sensor | | |

# Simple Repair Procedures

The procedures described in this section can be done with the nano pump in place in the system stack.

**Table 14** Simple Repair Procedures

| Procedure | Symptom | Notes |
|---|---|---|
| "Exchanging the Active Inlet Valve Cartridge or the Active Inlet Valve" on page 109 | If internally leaking | Pressure ripple unstable, run leak test for verification |
| "Exchanging the Outlet Ball Valve Sieve or the Complete Valve" on page 112 | If internally leaking | Pressure ripple unstable, run leak test for verification |
| "Installing the Manual Purge Valve" on page 114 | Unstable column flow or system pressure | |
| "Installing the Manual Purge Valve" on page 114 | Column flow and system pressure drops from time to time. | A pressure drop of > 10 bar across the frit (2.5 ml/min $H_2O$ with purge open) indicates blockage |
| "Exchanging the Pump Seals and Seal Wear-in Procedure" on page 122 | If pump performance indicates seal wear | Leaks at lower pump head side, unstable retention times, pressure ripple unstable — run leak test for verification |
| "Exchanging the Plungers" on page 125 | If scratched | Seal life time shorter than normally expected — check plungers while changing the seals |
| "Exchanging the Flow Sensor" on page 126 | Extended flow range (100 µl) needed.<br>Leak on the flow sensor.<br>Unstable column flow<br>Flow sensor blocked | |

# Exchanging the Active Inlet Valve Cartridge or the Active Inlet Valve

| | |
|---|---|
| **Frequency** | If internally leaking (backflow) |
| **Tools required** | Wrench 14 mm |
| **Parts required** | Active inlet valve G1312-60010<br>Valve Cartridge 5062-8562 |

## Removing the Active Inlet Valve

1 Unplug the active inlet valve cable from the connector.

2 Disconnect the solvent inlet tube at the inlet valve. Beware of leaking solvents.

3 Using a 14-mm wrench loosen the active inlet valve and remove the valve from pump head.

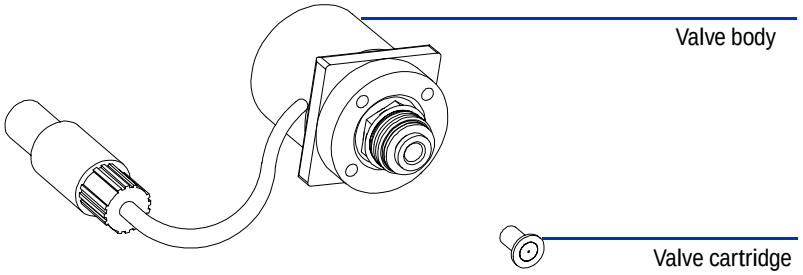



**Figure 14** Active Inlet Valve Parts

## Exchanging the Valve Cartridge

1 Using a pair of tweezers remove the valve cartridge from the actuator assembly.

2 Before inserting the new valve cartridge clean the area in the actuator assembly. Fill a syringe with alcohol and flush the cartridge area thoroughly.

3 Insert a new valve cartridge into the actuator assembly. Make sure the valve cartridge is fully inserted into the actuator assembly.

## Replacing the Active Inlet Valve

1 Insert the new valve into the pump head. Using the 14 mm wrench turn the nut until hand tight.

2 Position the valve that the solvent inlet tube connection points towards the front.

3 Using the 14 mm wrench tighten the nut by turning the valve in its final position (not more than a quarter turn). Do not overtighten the valve. The solvent inlet tube connection should point to the right corner of the pump head.

4 Reconnect the inlet tube and the active inlet valve cable to the connector at the Z-panel.

NOTE Make sure you are in **normal mode.**

5 After an exchange of the valve cartridge it may take several mL of pumping with the solvent used in the current application, before the flow stabilizes at A%-ripple as low as it used to be, when the system was still working properly.

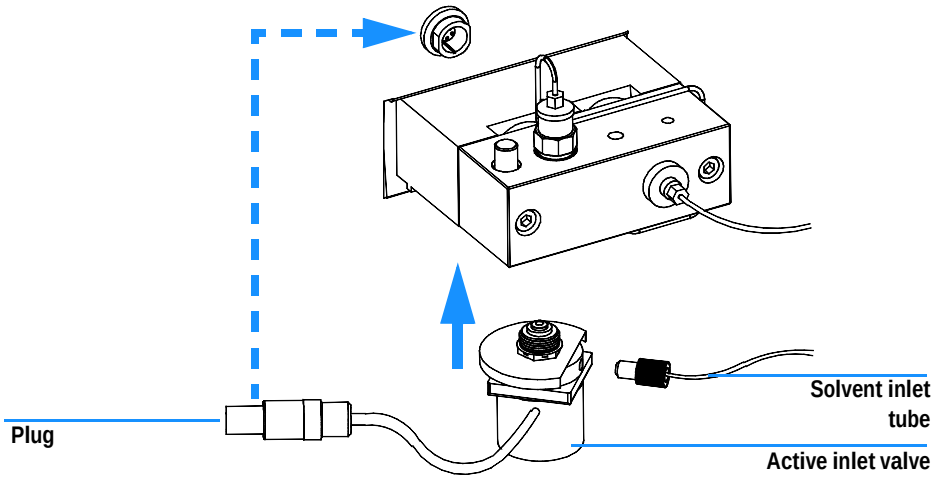



**Figure 15** Exchanging the Active Inlet Valve

# Exchanging the Outlet Ball Valve Sieve or the Complete Valve

| | |
|---|---|
| **Frequency** | Sieve — whenever the pump seals will be exchanged<br>Valve — if internally leaking |
| **Tools required** | Wrench 1/4 inch<br>Wrench 14 mm |
| **Parts required** | Outlet ball valve G1312-60008<br>Sieve (pack of 10) 5063-6505 |

NOTE Before exchanging the outlet ball valve you can try to clean it in a sonic bath. Remove the gold seal and the sieve. Place the valve in upright position (onto the plastic cap) in a small beaker with alcohol. Place in a sonic bath for 5 to 10 minutes. Insert a new sieve and replace the gold seal.

1 Using a 1/4 inch wrench disconnect the valve capillary from the outlet ball valve.

2 Using the 14 mm wrench loosen the valve and remove it from the pump body.

3 Remove the plastic cap with the gold seal from the outlet ball valve.

4 Using a pair of tweezers remove the sieve.

NOTE Check the gold seal. It should be exchanged when strongly deformed.
Place the valve in an upright position, insert the sieve into the recess and replace the gold seal with the cap. Make sure that the sieve cannot move and is away from the seal area of the gold seal.

5 Place a new sieve into the recess of the outlet ball valve and replace the cap with the gold seal.

6 Check that the new valve is assembled correctly and that the gold seal is present.

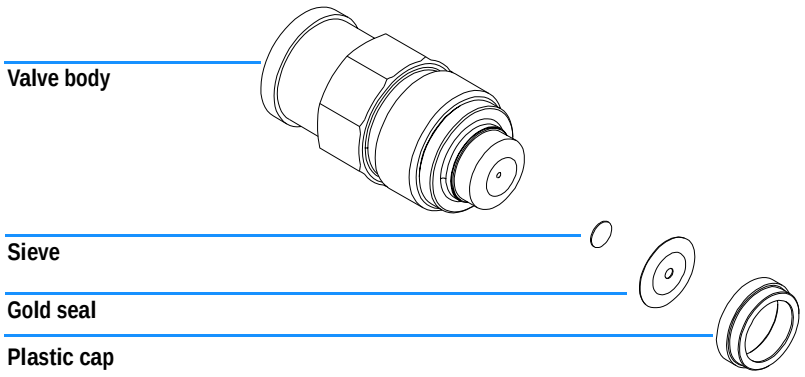



**Figure 16** Outlet Ball Valve Parts

7 Reinstall the outlet ball valve and tighten the valve.

8 Reconnect the valve capillary.

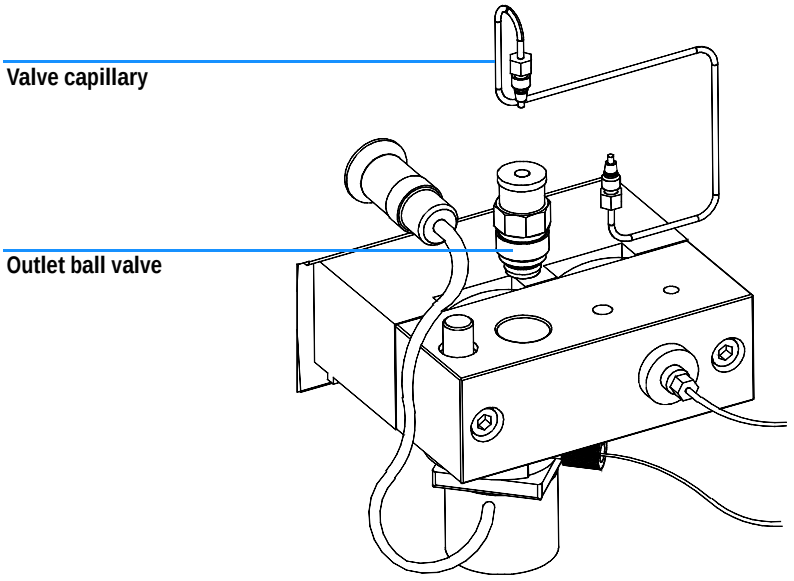



**Figure 17** Exchanging the Outlet Ball Valve

# Installing the Manual Purge Valve

| | |
|---|---|
| **Frequency** | When performing a leak test for verifying pump tightness<br>When using the nano pump permanently in normal mode |
| **Tools required** | Wrench 1/4 inch<br>Wrench 14 mm<br>Wrench 4 mm |
| **Parts required** | Purge valve assy G1311-60009<br>Adapter G1312-23200<br>Screw 0515-0175<br>Washer 2190-0586 |

## Installing the Purge Valve

1. Switch off the pump module.
2. Disconnect the capillary from the mixer to the filter at the filter inlet.
3. Connect the capillary end into the purge valve holder.
4. Adapt the purge valve holder on the pump head of channel A.
5. Use the screw and the washer to fix the purge valve holder.
6. Insert the purge valve assembly into the purge valve holder and locate the outlet and waste outlet as shown below.
7. Use the 14 mm wrench to tighten the purge valve assembly.
8. Connect the waste tube from the EMPV assembly to the waste outlet of the purge valve.
9. Connect the pump outlet capillary into the outlet of the purge valve.

# Exchanging the Purge Valve Frit or the Complete Manual Purge Valve

| | |
|---|---|
| **Frequency** | Frit **-** when plunger seals are exchanged or when contaminated or blocked (pressure drop of > 10 bar across the frit at a flow rate of 2500 µl/min of $H_20$ with purge valve opened)<br>Purge valve - if internally leaking |
| **Tools required** | Wrench 1/4 inch<br>Wrench 4 mm (depending on pump outlet capillary)<br>Wrench 14 mm<br>Pair of tweezers or toothpick |
| **Parts required** | PTFE Frit (pack of 5) 01018-22707<br>Purge valve G1311-60009 |

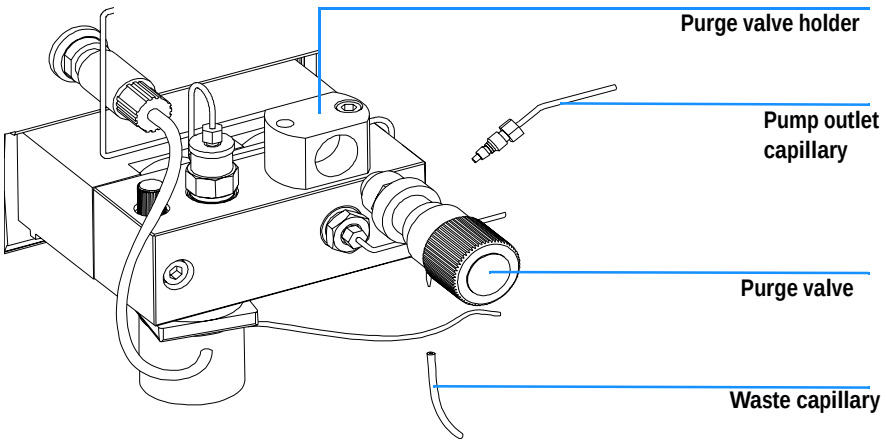



**Figure 18** Exchanging the Purge Valve Frit

**Exchanging the purge valve frit or the complete purge valve**

1 Using a 1/4 inch or 4 mm wrench disconnect the pump outlet capillary at the purge valve.

2 Disconnect the waste tube. Beware of leaking solvents due to hydrostatic pressure.

3 Using the 14 mm wrench unscrew the purge valve and remove it from the purge valve holder.

4 Remove the plastic cap with the gold seal from the purge valve.

5 Using a pair of tweezers or a toothpick to remove the frit.

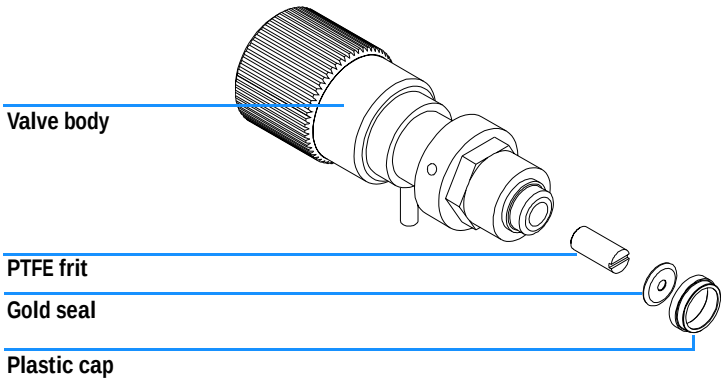



**Figure 19** Purge Valve Parts

6 Place a new frit into the purge valve with the orientation of the frit as shown above.

7 Replace the cap with the gold seal.

NOTE Before reinstallation always check the gold seal. A deformed seal should be exchanged.

8 Insert the purge valve into the purge valve holder and locate the pump outlet and the waste outlet as shown below.

9 Tighten the purge valve, reconnect outlet capillary and waste tubing.

NOTE When fused silica capillaries are used, use the 4 mm wrench together with the torque tool to avoid overtightening.

# Exchanging the EMPV Assembly

| | |
|---|---|
| **Frequency** | If valve internally leaking<br>If unstable column flow in micro mode<br>If column flow and system pressure drops from time to time. |
| **Tools required** | Wrench 1/4 inch<br>Wrench 14 mm<br>Wrench 7/16 inch |
| **Parts required** | EMPV assembly G1361-60000 |

### Exchanging the complete EMPV

1 Turn the pump off.

2 Remove the pump from the stack and remove the top cover and foam.

3 Using a 1/4 inch wrench disconnect the capillaries:
- going to the flow sensor.
- coming from the filter.

4 Disconnect the waste tube. Beware of leaking solvents due to hydrostatic pressure.

5 Disconnect the EMPV connector (P9) on the main board see Figure 22 on page 135.

6 Using a hex key, unscrew the complete EMPV and remove it.

7 Screw a new one in place.

8 Reconnect the capillaries:
- going to the flow sensor.
- coming from the filter.

9 Run the EMPV test see "EMPV Test" on page 84.

# Exchanging the Solvent Selection Valve

| | |
|---|---|
| **Frequency** | If internally leaking (crossfoot between the ports), or if one of the channels is blocked |
| **Tools required** | Screwdriver Pozidriv #1 |
| **Parts required** | Solvent selection valve (PN gives half of a complete solvent selection block) G1312-60000 |

1 Disconnect the solvent tubes and the active inlet valve connection tubes from the solvent selection valves. Place solvent tubes into the solvent cabinet to prevent leaks due to hydrostatic flow.

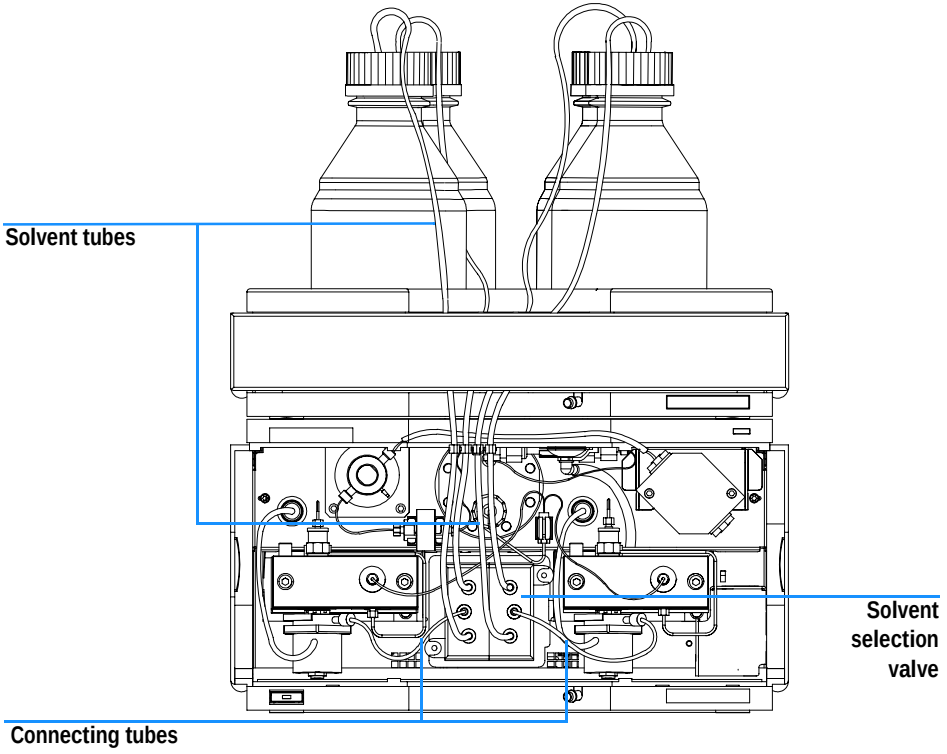



**Figure 20** Exchanging the solvent selection valve

2 Using a Pozidriv screwdriver #1 loosen the holding screws of the valves.

3 Pull the valve module out of its connector.

4 Hold the two plastic bodies of the valves and pull the two solvent selection valves apart.

5 Exchange the defective solvent selection valve. Press the exchanged valve (new half) together with the properly working old half.

6 Connect the valve module to its electrical connectors and fix the assembly with the two holding screws.

7 Reinstall solvent tubes and the active inlet valve connection tubes

# Removing and Disassembling the Pump Head Assembly

**CAUTION** **Never start the pump when the pump head is removed. This may damage the pump drive.**

**When required:**

- Exchanging the seals
- Exchanging the plungers
- Exchanging seals of the seal wash option

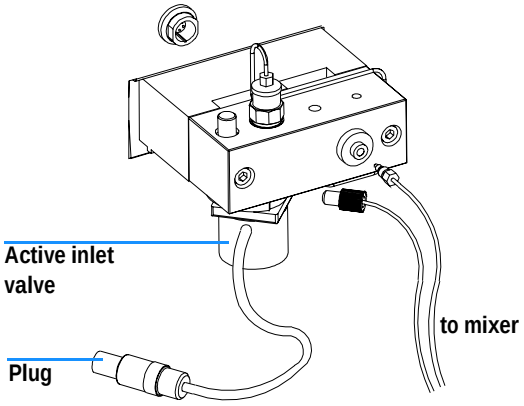
**Tools required:**

- Wrench 1/4 inch
- 3-mm hexagonal key
- 4-mm hexagonal key

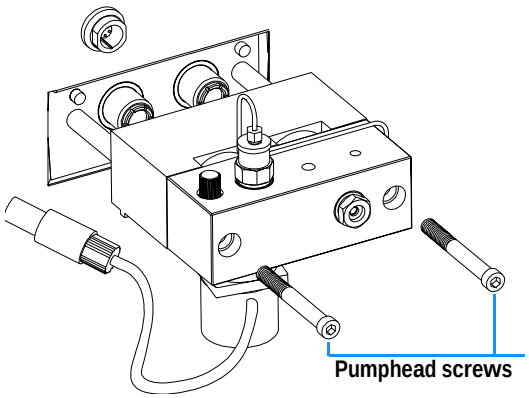
**Preparations for this procedure:**

- Switch off nano pump at power switch
- Remove the front cover to have access to the pump mechanics

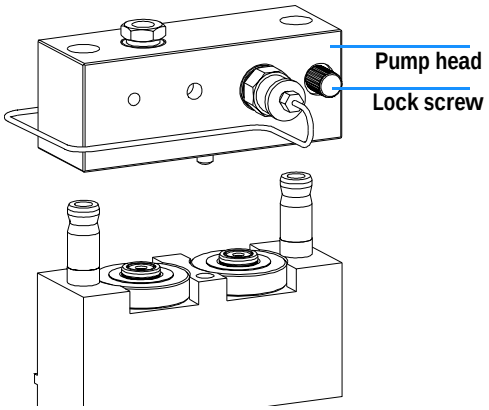
**1** Disconnect the capillary at the pumphead adapter and the tube at the active inlet valve. Beware of leaking solvents. Disconnect the active inlet valve cable plug.



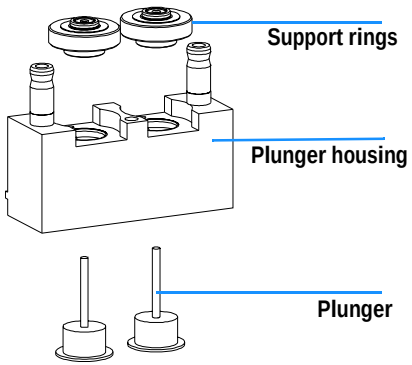
**2** Using a 4-mm hexagonal key step wise loosen and remove the two pump head screws and remove the pump head from the pump drive.




**3** Place the pump head on a flat surface. Loosen the lock screw (two revolutions). While holding the lower half of the assembly, carefully pull the pump head away from the plunger housing.




**4** Remove the support rings from the plunger housing and lift the housing away from the plungers.



# Exchanging the Pump Seals and Seal Wear-in Procedure

**When required:**

- Seals leaking, if indicated by the results of the leak test (Check both pump heads individually!)

**Tools required:**

- 3-mm hexagonal key
- 4-mm hexagonal key
- 1/4 inch wrench

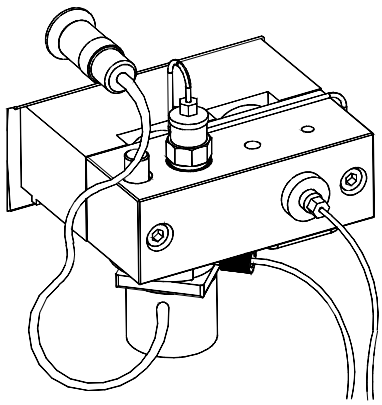
**Parts required:**

- Seals (pack of 2) 5063-6589 (standard) or 0905-1420 (for normal phase application)

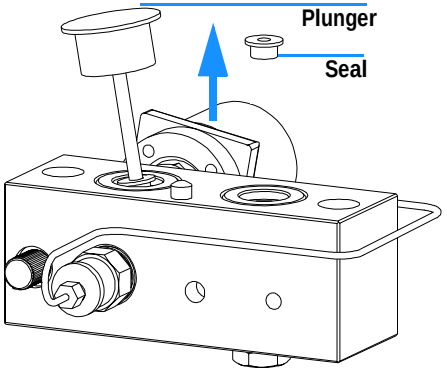
For the seal wear-in procedure:

- Restriction capillary (5022-2159)

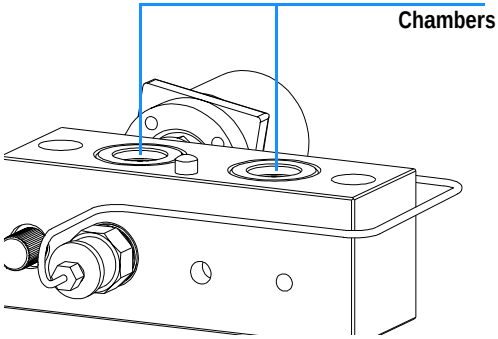
**1** Disassemble the pump head assembly of the leaky pump head (see "Removing and Disassembling the Pump Head Assembly" on page 120).



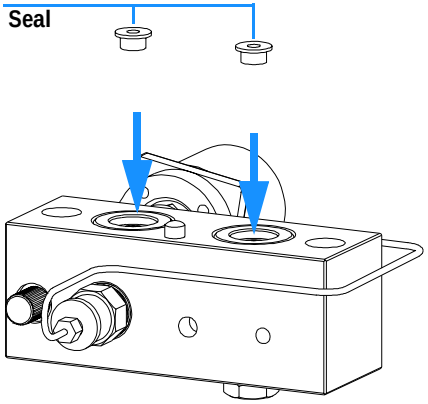
**2** Using one of the plungers carefully remove the seal from the pump head (be careful, not to break the plunger). **Remove wear retainers, if still present.**



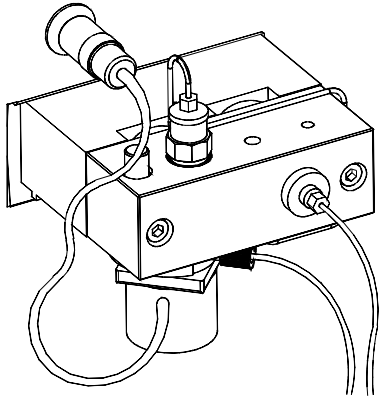

**3** Clean the pump chambers with lint free cloth. Ensure all particulate matter is removed. Best cleaning results will be achieved by removing all valves (see pages 109, 112) and the capillary. Inject solvent into each chamber.




**4** Insert seals into the pump head and press firmly in position.




**5** Reassemble the pump head assembly (see “Reassembling the Pump Head Assembly” on page 127). Reset the seal wear counter and liquimeter as described in the User Interface documentation.



### Seal Wear-in Procedure

**CAUTION** This procedure is required for standard seals only (5063-6589), but it will definitely damage the normal phase application seals (0905-1420).

1. Fill a bottle with 100 ml Isopropanol and place the bottle head assembly of the pump head that is supposed to be worn-in into the bottle.
2. Screw the adapter (0100-1847) to the AIV and connect the inlet tube from the bottle head directly to it.
3. Connect the restriction capillary (5022-2159) to the outlet of the EMPV. Insert its other end into a waste container.
4. Turn the system in **purge mode** and purge the system for 2 minutes with isopropanol at a flow rate of 2 ml/min.
5. Turn the system to **standard mode**, set the flow to a rate adequate to achieve a pressure of 350 bar. Pump 15 minutes at this pressure to wear in the seals. The pressure can be monitored at your analog output signal, with the handheld controller, Chemstation or any other controlling device connected to your pump.
6. Turn **OFF** the pump, slowly disconnect the restriction capillary from the EMPV to release the pressure from the system. Reconnect the capillary going to the flow sensor and the connecting tube from solvent selection valve to the AIV.
7. Rinse your system with the solvent used for your next application.

# Exchanging the Plungers

**When required:**

- When scratched

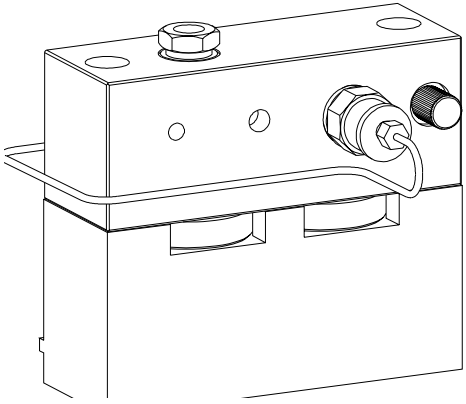
**Tools required:**

- 3-mm hexagonal key
- 4-mm hexagonal key

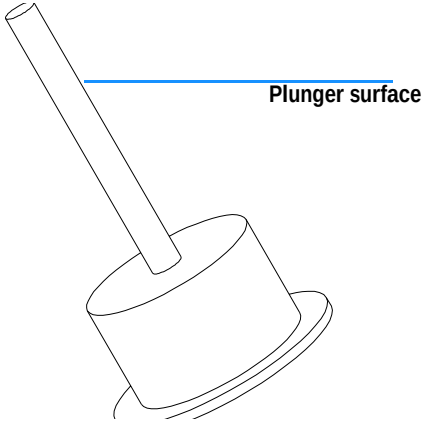
**Parts:**

- Plunger 5063-6586

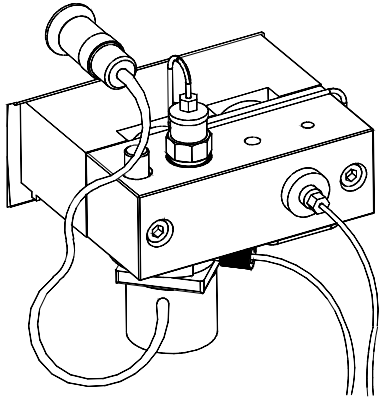
**1** Disassemble the pump head assembly (see "Removing and Disassembling the Pump Head Assembly" on page 120).



**2** Check the plunger surface and remove any deposits or layers. Cleaning can be done with alcohol or tooth paste. Replace plunger if scratched.




**3** Reassemble the pump head assembly (see "Reassembling the Pump Head Assembly" on page 127).



# Exchanging the Flow Sensor

| | |
|---|---|
| **Frequency** | Leak on the flow sensor.<br>Unstable column flow<br>Flow sensor blocked |
| **Tools required** | 8710-2412 2.5 mm hex key<br>8710-1534 4 mm open wrench |
| **Parts required** | G1376-60004 Nanoflow sensor<br>G2226-67300 Flow sensor accuracy calibration capillary (8000 mm, 25 um)<br>G2226-67300 |

1 Turn off the pump.

2 Disconnect the EMPV to flow sensor capillary on the flow sensor inlet.

3 Disconnect the flow sensor to sampler capillary on the flow sensor outlet.

4 Unscrew the flow sensor.

5 Install the new flow sensor.

6 Reconnect the EMPV to flow sensor capillary on the flow sensor inlet.

7 Connect the flow sensor accuracy calibration capillary (G2226-67300) on the flow sensor outlet.

8 Run the flow sensor accuracy calibration from the ChemStation. Follow the step by step procedure.

9 At the end of the procedure, disconnect the flow sensor accuracy calibration capillary.

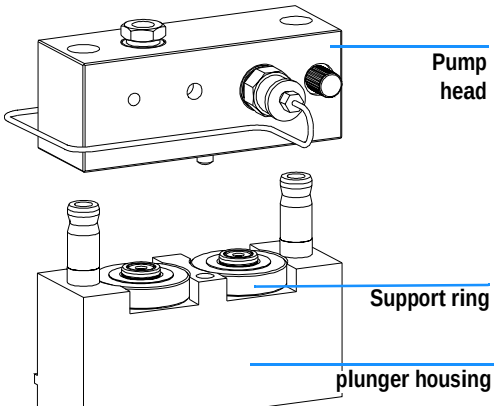
10 Reconnect the flow sensor to sampler capillary on the flow sensor outlet.

# Reassembling the Pump Head Assembly

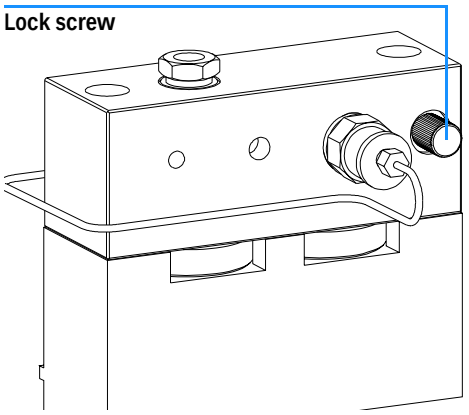
**Tools required:**

- 3-mm hexagonal key
- 4-mm hexagonal key
- PTFE lubricant (79841-65501)

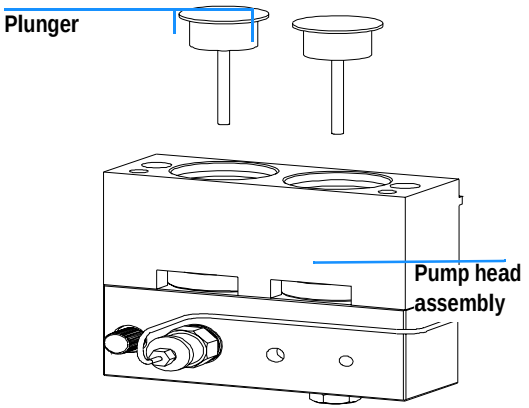
**1** Place the support rings on the plunger housing (plungers not installed) and snap the pump head and plunger housing together.



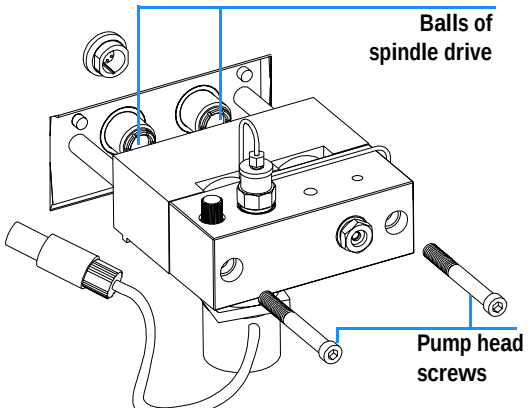

**2** Tighten the lock screw.



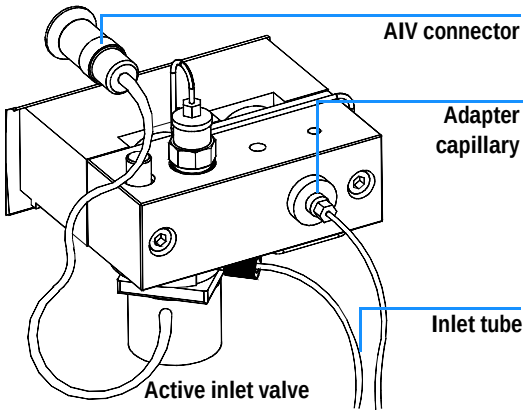

**3** Carefully insert the plungers into the pump head assembly and press them completely into the seals.



**4** Slide the pump head assembly onto the pump drive. Apply a small amount of pump head grease to the pumphead screws and the balls of the spindle drive. Tighten screws stepwise with increasing torque.




**5** Reconnect the capillaries, tubing and the active inlet valve cable to the connector.



# Exchanging the Optional Interface Board

**CAUTION** The interface board is sensitive to electrostatic discharge. Always use the ESD kit when handling electronic boards.

| | |
|---|---|
| **When required** | Board defective |
| **Part required** | BCD (Interface) board, see "Optional Interface Boards" on page 215 |

1 Switch off the nano pump at the main power switch. Unplug the pump from main power.

2 Disconnect cables from the interface board connectors.

3 Loosen the screws. Slide out the interface board from the nano pump.

4 Install the new interface board. Secure screws.

5 Reconnect the cables to the board connector

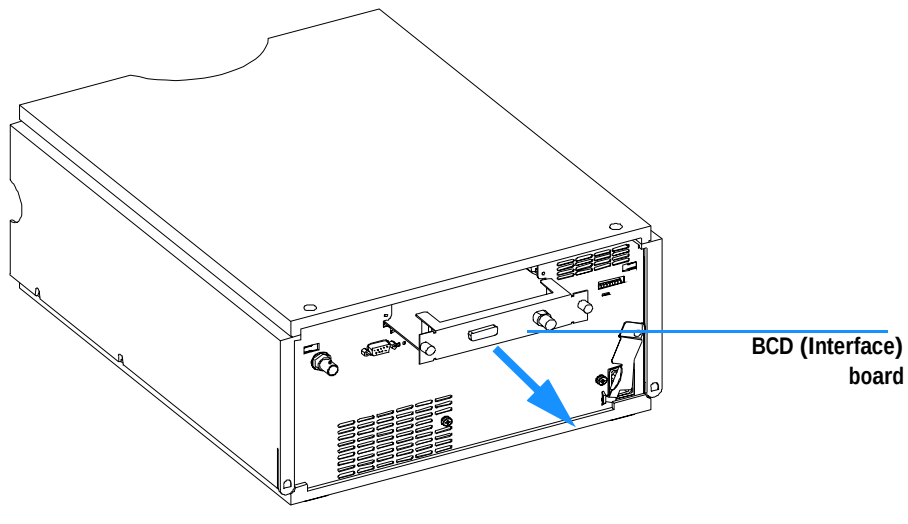



**Figure 21** Exchanging the Interface Board

# Exchanging Internal Parts

**WARNING** **The following procedures require opening the main cover of the nano pump. Always ensure the nano pump is disconnected from the line power when the main cover is removed. The security lever at the power input socket prevents that the pump cover is taken off when line power is still connected.**

**WARNING** **To disconnect the nano pump from line, unplug the power cord. The power supply still uses some power, even if the switch on the front panel is turned off.**

**WARNING** **When opening capillary or tube fittings solvents may leak out. Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.**

NOTE The electronics of the nano pump will not allow operation of the nano pump when the top cover and the top foam are removed. A safety light switch on the main board will inhibit the operation of the nano pump. Always operate the nano pump with the top foam and top covers in place.

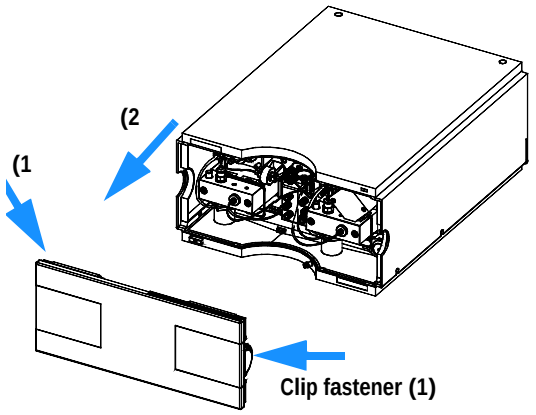
**CAUTION** Internal components may be sensitive to electrostatic discharge (ESD). Always use an ESD kit when handling internal parts.

The procedures in this section describe how to exchange internal parts. You must remove the nano pump from the stack in order to open the main cover.

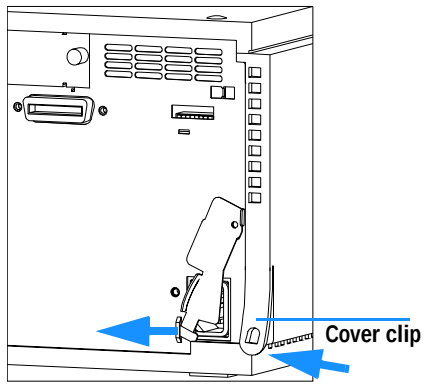
## Removing the Top Cover and Foam

| | |
|---|---|
| **Tools required** | Screwdriver Pozidriv #1 |
| **Preparations for this procedure** | Switch off nano pump at the main power switch.<br>Disconnect the solvent inlet tubes from the solvent selection valve or the adapter at the active inlet valve.<br>Beware of leaking solvents due to hydrostatic flow.<br>Remove leak funnel with the waste tube.<br>Remove the solvent cabinet from the nano pump. |

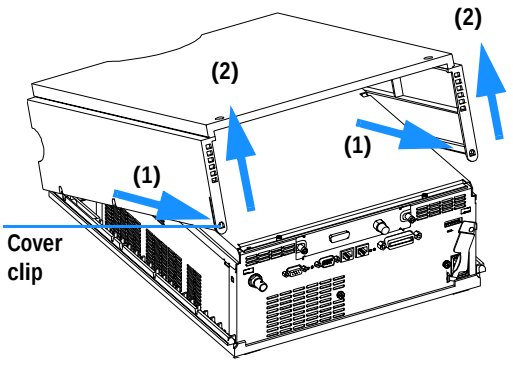
**1** Remove the front cover by pressing the clip fastener on both sides of the cover.



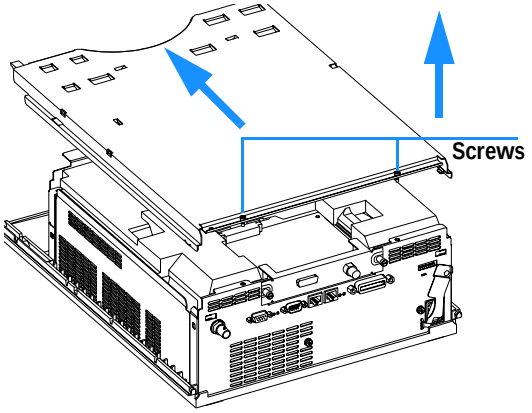

**2** Unplug the power cord and move the lever towards the power socket.



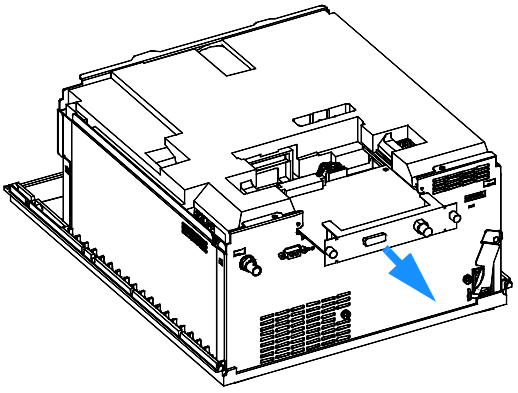
**3** Lift the clips on both sides of the top cover (1). Remove the top cover (2).



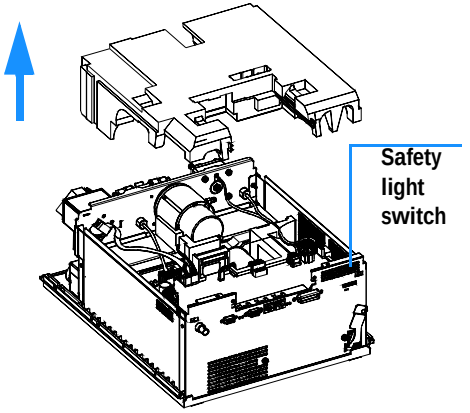

**4** Unscrew the screws on the top plate and remove the plate by lifting its back first and then sliding to the front.




**5** If an optional interface board is installed, remove it from the nano pump.



**6** Remove the top foam.

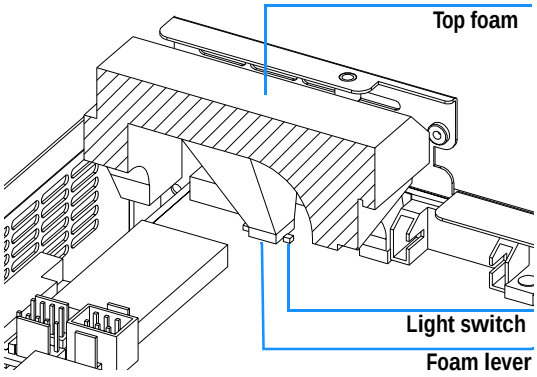


Do not connect a power plug to the nano pump module after removing the top covers.

A safety light switch on the main board will prevent operation when the covers are removed.

The next figure shows the position of the light switch on the board.

**7** Position of the safety switch on the main board.



## Exchanging the Nano Pump Main Board (NPM Board)

| | |
|---|---|
| **Frequency** | Board defective |
| **Tools required** | Wrench 14 mm<br>Wrench 7 mm<br>Wrench 5 mm |
| **Parts required** | NPM board, G2226-66530, exchange part number G2226-69530 |

1 Turn off the pump, disconnect all cables and remove the pump from the stack.

2 Remove the top covers and foam, see “Removing the Top Cover and Foam” on page 131.

3 Disconnect all connectors from the main board.

| Connector | Description | Connector | Description |
|---|---|---|---|
| S1 | Configuration switch | | |
| J1 | GPIB | P11 | AIV - A |
| J2 | CAN connector | P15 | Leak sensor |
| J3 | CAN connector | P16 | Damper |
| J4 | RS232 | P17 | Fan |
| J5 | Remote | P18 | Interface board |
| J6 | Analog output | P21 | Encoder B |
| P2 | Power supply | P20 | AIV-B |
| P8 | Motor B | P22 | Solvent Selection Valve |
| P12 | Motor A | P9 | EMPV |
| P14 | Encoder A | P19 | Flow sensor |

NOTE When removing connectors, counterhold on connector J3 with one hand.

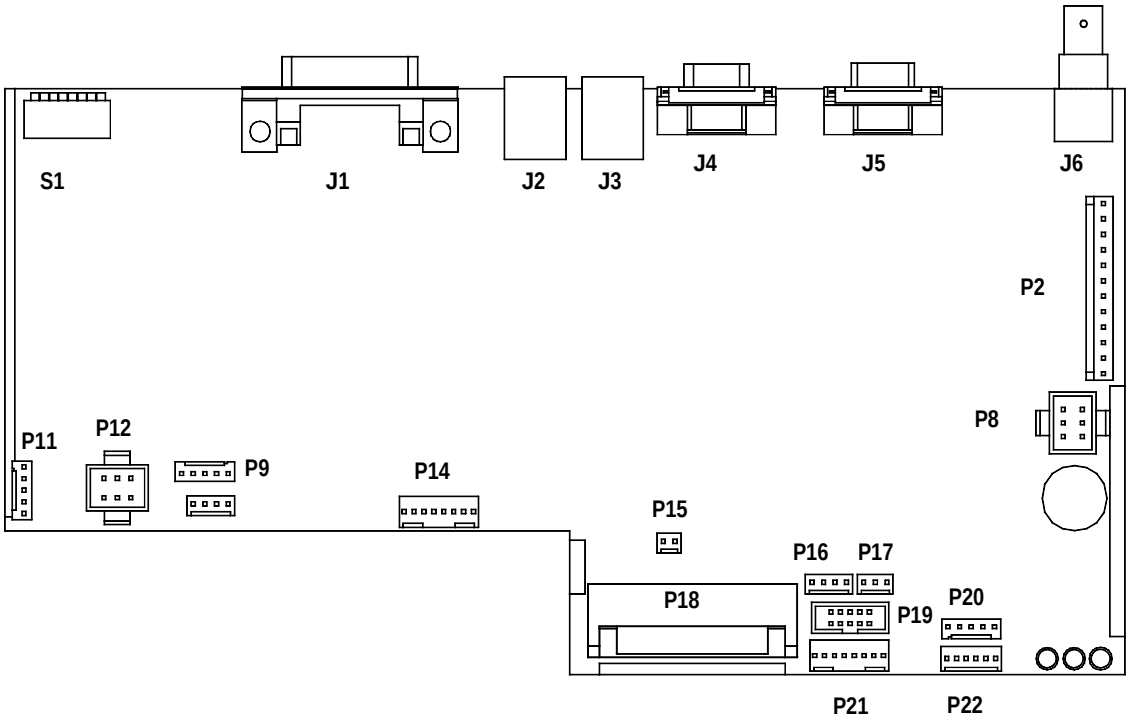



**Figure 22** Board Layout of the NPM Board

4 Remove the connector screws from the GPIB, Remote and from the analog pressure output connector.

5 Remove the board. Place it on an ESD kit.

**WARNING** **The RFI spring plate sitting on the board connectors is very sharp! Be careful, not to cut yourself, when removing it from the old board and sliding it onto the new board.**

6 In most cases the RFI spring plate (Radio Frequency Interference spring plat, prevents radio emissions from the instrument to ambient) remains on the interface connectors of the board. Carefully remove the spring plate from the old board and slide onto the new board before installing the new board in the pump (the RFI spring plate is NOT part of an exchange board).

7 If you have to exchange other parts, also, continue with that work first.

8 On the new board check the switch setting of address switch S1, see Table 51 on page 219.

NOTE An incorrect switch setting (e.g., TEST/BOOT) may cause the pump to turn into a basic mode (yellow or red flashing status light). In such a case turn off the pump, re-set the address switches, and turn on the pump again.

9 Install the new board and reconnect the connectors. Make sure that the board is fitted correctly in the board recess holes at the rear panel.

**CAUTION** Make sure that P21 is not accidentally connected into the position of P16-P17 (possible on revision A and B boards). This will damage the encoder of pump drive B when turned on.

10 Replace the connector screws.

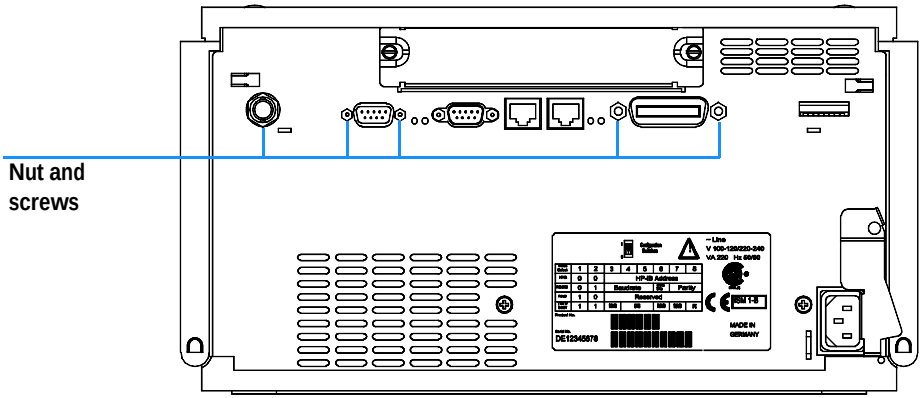



**Figure 23** Rear of Nano Pump

11 Replace foam and top covers, see “Replacing the Top Cover and Foam” on page 154.

12 Reinstall the pump in the stack. Reconnect all cables. Turn on the nano pump. If the status indicator turns red, continue with the section “Entering

the Type Command” on page 137, other whise continue with the section “Entering the Serial Number” on page 139.

## Entering the Type Command

NOTE After the installation of a new mainboard the *TYPE* (binary) of the module is normally automatically detected. The specific *TYPE* tells the pump how to configure itself during turn on. In some cases, especially when a defective mainboard is replaced with an older version of mainboard, the automatic *TYPE* detection does not work. When the *TYPE* of the exchange main board does not match the pump, a pump configuration error will occur during pump turn on. This will cause the pump status indicator to be red. In this case the *TYPE* of the module has to be entered using the procedure described in the following sections.

You must change the *TYPE* of the replacement main board to agree with the nano pump (G2226A). The *TYPE* can be entered using either the control module or the ChemStation, see “Entering the Type Command using the Control Module” on page 137 or “Entering the Type Command using the ChemStation” on page 138.

### Entering the Type Command using the Control Module

1 Connect the control module to the pump.

2 From **Views** (press F5) select the **System** screen, then press **Tests** (F3).

3 Using the up/down arrows, make sure that the nano pump is highlighted and press **Enter**. The Tests screen for the nano pump should now be displayed.

4 While in the **Tests** screen, press `m.m` (m dot m). From the box now displayed, select the **Command** line, and press **Enter**.

5 Into the box labeled **Instr**, enter the command `TYPE G2226A`.

NOTE Letters and numbers are created using the up and down arrows. There must be a blank space between the word TYPE and the letter G.

It is important to enter the TYPE command correctly. An incorrect type command may cause the module to turn on in it's resident mode. In such a case, re-enter the TYPE command correctly.

6 When the command is entered, press **Enter** to highlight the complete command.

7 Press the **Execute** (F8) key. Below the box, a reply line should then say: **Reply RA 0000 TYPE "G2226A"**.

8 Turn off the module, then turn it on again. Turn on should be normal. In the **Records** screen, the product# column should indicate the nano pump. If a ChemStation is also connected, re-boot it now.

### Entering the Type Command using the ChemStation

The TYPE is entered by typing a specific command into the command line at the bottom of the main user interface screen.

1 To enter the TYPE for a specific module, type the following command into the command line:

```
print sendmodule$ (lpmp, "TYPE G2226A")
```

NOTE It is important to enter the TYPE command correctly. An incorrect type command may cause the module to turn on in it's resident mode. In such a case, re-enter the TYPE command correctly.

2 The reply line will respond with **RA 0000 Type "G2226A".**

3 Turn the nano pump off, then on again. Then, re-boot the ChemStation. Boot up and subsequent control of the system should be normal.

4 The TYPE of a module can also be identified by typing the following command into the command line:

```
print sendmodule$ (lpmp, "TYPE?")
```

The reply line will give the module **TYPE**.

## Entering the Serial Number

### Entering the Serial Number using the Control Module

1 Connect the control module to the nano pump. Turn on the pump.

2 In the control module, press **Views** *(F5)* and select the **system** screen, then press **Records** *(F4)*. Using the up/down arrows, make sure that the nano pump is highlighted.

3 Press **FW Update** *(F5)*. Now, press the **m** key. This will display a box which says **Update Enter Serial#**.

4 Press **Enter**. This will display the box labeled **Serial#**.

5 Letters and numbers are created using the up and down arrows. Into the box labeled **Serial#**, enter the 10-character serial number for the nano pump. When the 10-character serial number is entered, press **Enter** to highlight the complete serial number. Then, press **Done** *(F6)*.

**CAUTION** For firmware revisions below A02.00 it is very important never to press **Done** if the Serial# box is blank. In this case, the module can no longer be recognized by either the control module or the ChemStation. The main board must then be replaced.

6 Turn the nano pump off, then on again. The **Records** screen should display the correct serial number.

7 If a ChemStation is also connected, re-boot the ChemStation now as well.

### Entering the Serial Number using the ChemStation

Module serial numbers are entered by typing specific commands into the command line at the bottom of the main user interface screen.

1 To enter a module serial number, type the following command into the command line:

```
print sendmodule$ (lpmp, "ser YYYYYYYYYY")
```

Where: YYYYYYYYYY is the 10-character serial number of the nano pump

**NOTE** The first two characters are letters, which should be capitalized.

The reply line will respond with **RA 0000 SER** followed by the module serial number you just entered.

2 Turn off the nano pump, then on again. Then, re-boot the ChemStation. If the serial number you have just entered is different than the original module serial number, you will be given the opportunity to edit the configure 1100 access screen during the re-boot of the ChemStation.

3 After boot-up, the serial number you have just entered can be seen under the **Instrument menu** of the main user interface screen. The serial number of the nano pump can also be seen by typing the following command into the command line:

```
print sendmodule$ (lpmp, "ser?")
```

The reply line will give the serial number of the nano pump.

## Replacing the Nano Pump's Firmware

The installation of new firmware is required

- if a new version solves problems of the currently installed version.
- if the version of firmware on the new main board (NPM) after an exchange of the board is older than the one previously installed.

To upgrade the nano pump's firmware follow the procedures and instructions given on the internet http://lsbu.marketing.agilent.com/start/start.asp.

To download and install always the newest available version of firmware on your system or call your local service provider for assistance.

## Exchanging the Damper

| | |
|---|---|
| **Frequency** | No pressure output or when leaking |
| **Tools required** | Screwdriver Pozidriv #1<br>Wrench 1/4 inch |
| **Parts required** | 79835-60005 Damper |

NOTE Do not totally remove the Z-panel when the damper is in its place. The heavy damper may fall down.

1 Remove the pump from the stack, remove the front cover, top cover and top foam section (see “Removing the Top Cover and Foam” on page 131).

2 Disconnect both active inlet valve cables.

3 Remove the EMPV. For this disconnect first:
- the capillary going to the flow sensor.
- the capillary coming from the filter.
- the waste tube.
- the connector.

4 Remove the flow sensor. For this disconnect first:
- the capillary coming from the EMPV.
- the capillary on the injection device (port 1).

5 Unclip the mixing chamber from its holder.

6 Remove the damper and the Z-panel. For this disconnect first:
- the restriction capillary.
- the capillary going to the mixer.
- the connector (P16, P11, P20) at the main board (see Figure 22 on page 135)

7 Unclip the mixing chamber from its holder

8 Loosen the screws of the Z-panel, fold it forward and remove the damper.

9 Re-install the Z-panel and the new damper. Reconnect the capillaries and connectors. (P16, P11, P20) (see Figure 22 on page 135)

10 Re-install the mixing chamber in its holder

11 Re-install the flow sensor. Reconnect the capillaries and the cable.

12 Re-install the EMPV. Reconnect the capillaries, the waste tube and the cable.

13 Reconnect both active inlet valve cables.

14 Replace the top foam section, optional interface board, front cover, and top cover (see “Replacing the Top Cover and Foam” on page 154).

## Exchanging the Fan

| | |
|---|---|
| **Frequency** | Fan not running |
| **Tools required** | Screwdriver Pozidriv #1<br>Wrench 1/4 inch |
| **Parts required** | Fan, PN 3160-1017 |

1 Remove the pump from the stack, remove the front cover, top cover and top foam section (see “Removing the Top Cover and Foam” on page 131).

2 Remove the EMPV. For this disconnect first:
- the capillary going to the flow sensor.
- the capillary coming from the filter.
- the waste tube.
- the connector.

3 Remove the flow sensor. For this disconnect first:
- the capillary coming from the EMPV.
- the capillary on the injection device (port 1).
- the connector.

4 Unclip the mixing chamber from its holder.

5 Remove the damper and the Z-panel. For this disconnect first:
- the mixing capillary.
- the capillary going to the mixer.
- the active inlet valve cable at the Z-panel.
- the connector (P16, P11, P20) at the main board (see Figure 22 on page 135)

6 Remove pump assembly B. For this, disconnect first:
- the capillary coming from the mixing chamber.
- the connecting tube coming from the solvent selection valve.
- the connector (P8, P21) at the main board.
- Unclip the mixing chamber from its holder

7 Disconnect the fan cable (P17) at the main board and slide the fan towards the front and move it out of the unit.

8 Place the new fan into the recess. Make sure that the air flow is directed as indicated (arrow on the fan points in the same direction as on the foam).Connect the cable to the main board (P17).

9 Re-install pump assembly B. Reconnect all capillaries and connectors. (P8, P21).

10 Re-install the Z-panel and the damper. Reconnect the capillaries and connectors. (P16, P11, P20)

11 Re-install the mixing chamber to its holder.

12 Re-install the flow sensor. Reconnect the capillaries and the cable.

13 Re-install the EMPV. Reconnect the capillaries, the waste tube and the cable.

14 Replace the top foam section, optional interface board, front cover, and top cover (see “Replacing the Top Cover and Foam” on page 154).

## Exchanging a Pump Drive

**WARNING** **Never start the pump when the pump head is removed. This may damage the pump drive.**

The nano pump has two pump-drive assemblies. The A drive is located on the left side and the B drive on the right side.

| | |
|---|---|
| **Frequency** | Error message: Motor Drive Power |
| **Tools required** | • Screwdriver Pozidriv #1<br>• Wrench 1/4 inch<br>• 4-mm hexagonal key<br>• |
| **Parts required** | • Pump drive G1311-60001, exchange part number G1311-69001 |

1 Remove the pump from the stack, remove the front cover, top cover and top foam section (see “Removing the Top Cover and Foam” on page 131).

2 Remove the EMPV. For this disconnect first:
- the capillary going to the flow sensor.
- the capillary coming from the filter.
- the waste tube.
- the connector.

3 Remove the flow sensor. For this disconnect first:
- the capillary coming from the EMPV.
- the capillary on the injection device (port 1).

4 Remove the pump head. For this, disconnect first:
- the capillary coming from the mixing chamber.
- the connecting tube coming from the solvent selection valve.
- the active inlet valve cable at the Z-panel.

5 Unclip the mixing chamber from its holder.

6 Remove the damper and the Z-panel. For this disconnect first:

- the mixing capillary.
- the capillary going to the mixer.
- the active inlet valve cable at the Z-panel.
- the connector (P16, P11, P20) at the main board (see Figure 22 on page 135).

7 Remove the pump drive. For this, disconnect first:
- the connector (P8, P21 or P12, P14) at the main board.

8 Place the new pump drive into the recess. Reconnect the connectors at the main board.

9 Re-install the Z-panel and the damper. Reconnect the capillaries and connectors. (P16, P11, P20).

10 Re-install the mixing chamber to its holder.

11 Re-install the pump head. Reconnect the capillaries and the cable.

12 Re-install the flow sensor. Reconnect the capillaries and the cable.

13 Re-install the EMPV. Reconnect the capillaries, the waste tube and the cable.

14 Replace the top foam section, optional interface board, front cover, and top cover (see “Replacing the Top Cover and Foam” on page 154).

## Exchanging the Power Supply

| | |
|---|---|
| **Frequency** | If defective |
| **Tools required** | • Screwdriver Pozidriv #1<br>• Wrench 1/4 inch<br>• Wrench 14 mm<br>• Wrench 7 mm<br>• Wrench 5 mm |
| **Parts required** | Power supply 0950-2528 |

1 **R**emove the pump from the stack, remove the front cover, top cover and top foam section (see “Removing the Top Cover and Foam” on page 131).

2 Remove the EMPV. For this disconnect first:
- the capillary going to the flow sensor.
- the capillary coming from the filter.
- the waste tube.
- the connector.

3 Remove the flow sensor. For this disconnect first:
- the capillary coming from the EMPV.
- the capillary on the injection device (port 1).
- the connector.

4 Unclip the mixing chamber from its holder.

5 Remove the damper and the Z-panel. For this disconnect first:
- the mixing capillary.
- the capillary going to the mixer.
- the active inlet valve cable at the Z-panel.
- the connector (P16, P11, P20) at the main board (see Figure 22 on page 135).

6 Remove both pump assemblies. For this, disconnect first:
- the capillary coming from the mixing chamber.
- the connecting tube coming from the solvent selection valve.
- the connector (P8, P21 and P12, P14) at the main board.

7 Disconnect the fan cable (P17) at the main board.

8 Remove the solvent selection valve. See “exchanging the solvent selection valve” in this chapter.

9 Remove the CSM board. Disconnect the remaining connectors, see “exchanging the high pressure pump main board in this chapter.

10 Push the leak sensor cable through the recess of the solvent selection valve and lift out the bottom foam.

11 Remove the power supply. For this:

- loosen and remove the power-supply screws at the rear panel.
- unclip the power supply light pipe from the power supply and pull out the coupler.

12 Place the new power supply into the instrument and fix it with the two screws at the rear panel

13 Place the coupler onto the switch in the power supply and clip the light pipe back onto the coupler.

14 Slide the leak sensor cable through the bottom foam and fix the leak sensor cable in the foam. Make sure the leak sensor cable is not damaged by the sheet metal.

15 Re-install the CSM board. Reconnect all the cables.

16 Re-install the solvent selection valve.

17 Re-install the two pump head. Reconnect the capillaries and the cable.

18 Re-install the Z-panel and the damper. Reconnect the capillaries and connectors. (P16, P11, P20)

19 Re-install the mixing chamber to its holder.

20 Re-install the flow sensor. Reconnect the capillaries and the cable.

21 Re-install the EMPV. Reconnect the capillaries, the waste tube and the cable.

22 Replace the top foam section, optional interface board, front cover, and top cover (see “Replacing the Top Cover and Foam” on page 154).

## Exchanging the Leak Sensor

| | |
|---|---|
| **Frequency** | Leak messages without leak in the funnel |
| **Tools required** | • Screwdriver Pozidriv #1<br>• Wrench 1/4 inch<br>• Wrench 14 mm<br>• Wrench 7 mm<br>• Wrench 5 mm |
| **Parts required** | Leak sensor, 5061-3356 |

1 Remove the pump from the stack, remove the front cover, top cover and top foam section (see “Removing the Top Cover and Foam” on page 131).

2 Remove the EMPV. For this disconnect first:
- the capillary going to the flow sensor.
- the capillary coming from the filter.
- the waste tube.
- the connector.

3 Remove the flow sensor. For this disconnect first:
- the capillary coming from the EMPV.
- the capillary on the injection device (port 1).
- the connector.

4 Unclip the mixing chamber from its holder.

5 Remove the damper and the Z-panel. For this disconnect first:
- the mixing capillary.
- the capillary going to the mixer.
- the active inlet valve cable at the Z-panel.
- the connector (P16, P11, P20) at the main board (see Figure 22 on page 135).

6 Remove both pump assemblies. For this, disconnect first:
- the capillary coming from the mixing chamber.
- the connecting tube coming from the solvent selection valve.
- the connector (P8, P21 and P12, P14) at the main board.

7 Disconnect the fan cable (P17) at the main board.

8 Remove the solvent selection valve. See “exchanging the solvent selection valve” in this chapter.

9 Remove the CSPM board. Disconnect the remaining connectors, see “exchanging the high pressure pump main board in this chapter.

10 Push the leak sensor cable through the recess of the solvent selection valve and lift out the bottom foam.

11 Unclip the leak pan and place it in front of the nano pump.

12 Pull the leak sensor out of the leak pan and lift the cable out of the metal plate.

13 Place the new leak sensor into the leak pan, see Figure 24 and replace the pan. Make sure that the cable is located in the recess of the bottom metal plate.

14 Reinstall the bottom foam. Make sure that the leak senor cable is guided through the foam to the top side.

15 Replace the main board, see “Exchanging the Nano Pump Main Board (NPM Board)” on page 134.

16 Re-install the solvent selection valve.

17 Re-install the two pump head. Reconnect the capillaries and the cable.

18 Re-install the Z-panel and the damper. Reconnect the capillaries and connectors. (P16, P11, P20)

19 Re-install the mixing chamber to its holder.

20 Re-install the flow sensor. Reconnect the capillaries and the cable.

21 Re-install the EMPV. Reconnect the capillaries, the waste tube and the cable.

22 Replace the top foam section, optional interface board, front cover, and top cover (see “Replacing the Top Cover and Foam” on page 154).

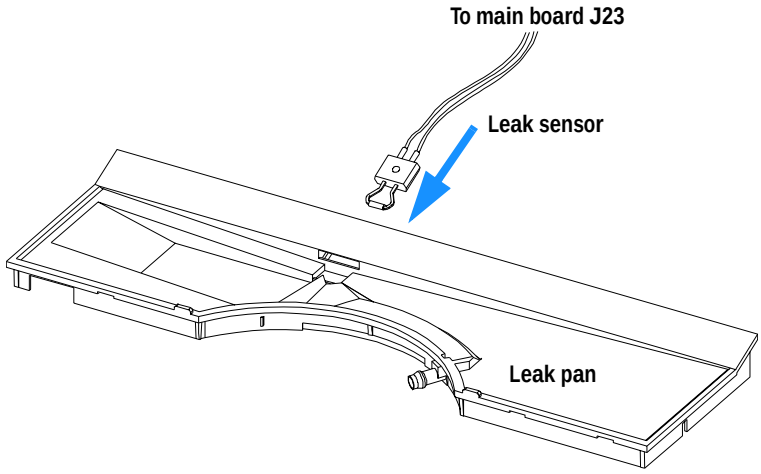



**Figure 24** Exchanging the Leak Sensor

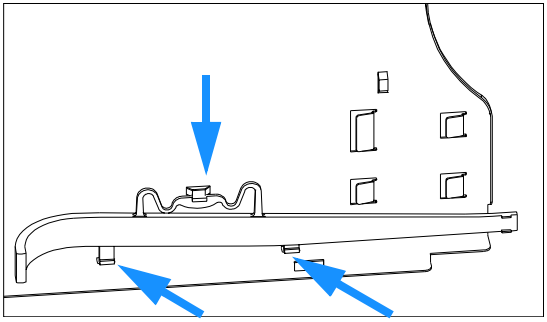
## Exchanging Status Light Pipe

| | |
|---|---|
| **Frequency** | If part is broken |
| **Tools required** | Screwdriver Pozidriv #1 |
| **Parts required** | Status light pipe 5041-8384 |

**Preparation for this procedure:**

- Remove the front cover and top cover, see “Removing the Top Cover and Foam” on page 131.

**1** The status light pipe is clipped into the top cover.



2 Replace the top cover, see “Replacing the Top Cover and Foam” on page 154.

3 Replace the nano pump into the stack and reconnect the cables and capillaries.

4 Turn on the nano pump.

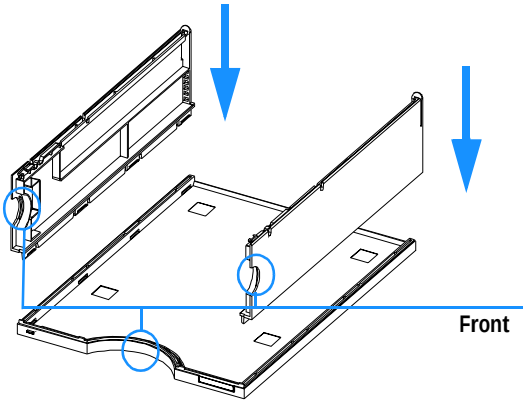
## Assembling the Main Cover

| | |
|---|---|
| **Frequency** | If cover is broken |
| **Tools required** | None |
| **Parts required** | Cover kit G1312-68703 (includes base, top, left and right) |

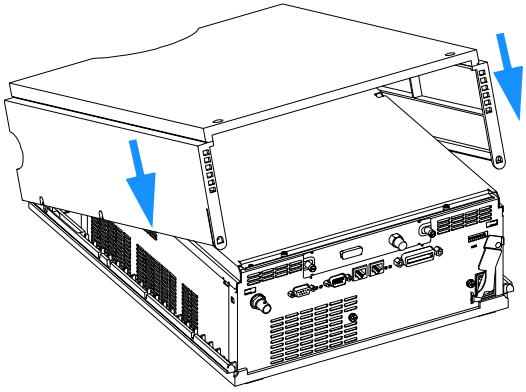
NOTE The cover kit contains all parts, but it is not assembled.

**WARNING** **In case you insert the left or right side in the opposite position, you may not be able to remove the side from the top part.**

**1** Place the top part on the bench and insert the left and right side into the top part.




**2** Replace the cover.



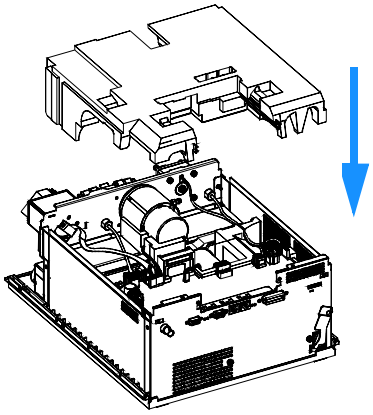
**3** Replace the nano pump into the stack and reconnect the cables and capillaries.

**4** Turn on the nano pump.

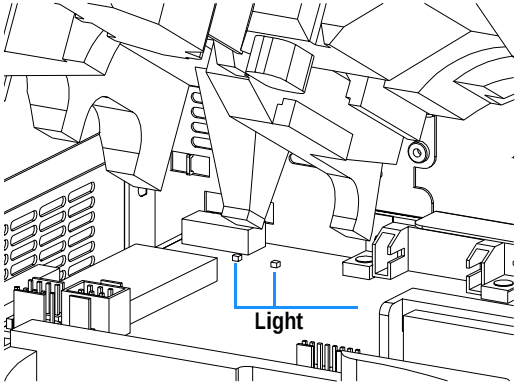
## Replacing the Top Cover and Foam

| | |
|---|---|
| **Tools required** | Screwdriver Pozidriv #1 |
| **Preparations for this procedure** | Make sure that after your repair all assemblies, cables, capillaries and connectors are located in its correct place. |

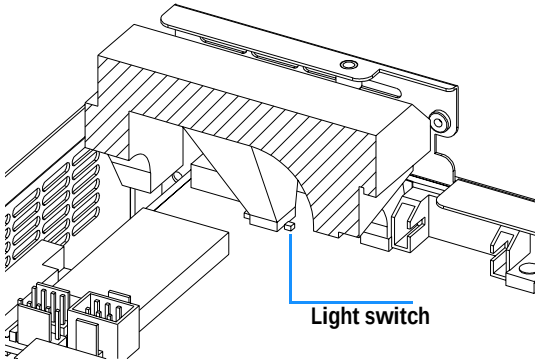
**1** Place the damper cable in a curve to the right side towards the active inlet valve cable of pump B. Replace the top foam section.



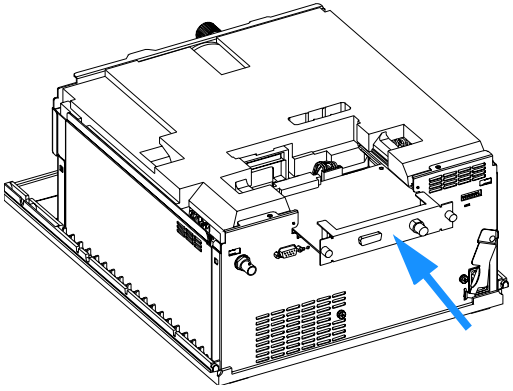
**2** Make sure that the foam is installed correctly and is located in the safety light switch.



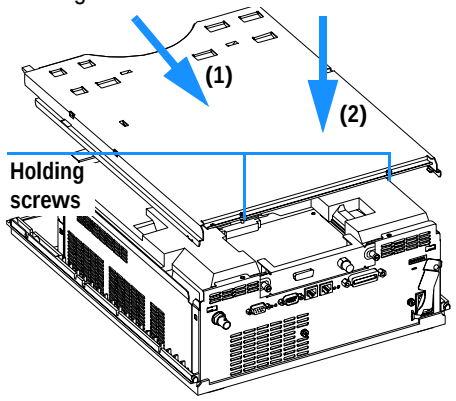

**3** Location of foam in the light switch.



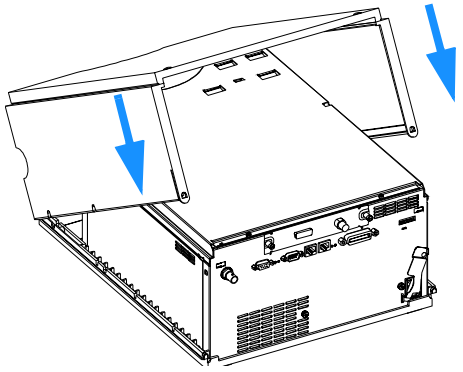

**4** Replace the optional interface board or the board cover plate.



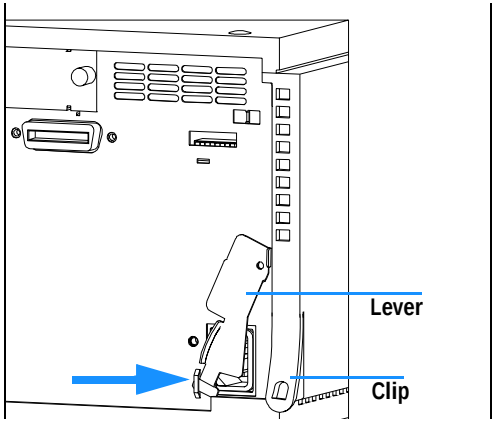
**5** Replace the metal cover (slide the metal tabs into place (1) underneath the Z-Panel in the front, then lower the back of the metal plate (2)) and fix the two holding screws.



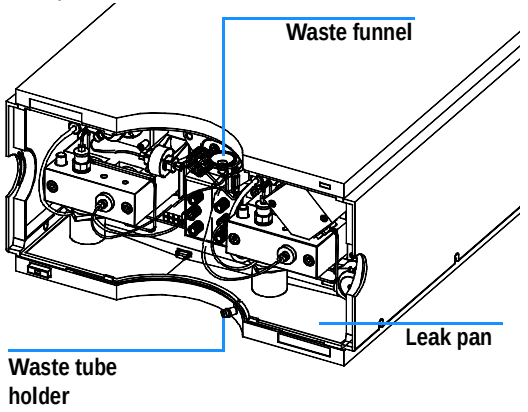

**6** Replace the top cover.



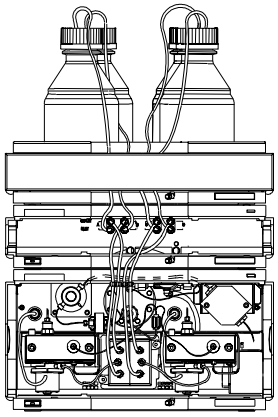
**7** Ensure clips are seated correctly, move lever back.




**8** Replace the leak funnel with the waste tube. Locate the lower end of the waste tube in the holder of the leak pan.



**9** Place the nano pump back to its position in the stack, replace solvent cabinet and reconnect all tubes and capillaries (figure shows configuration with solvent selection valve).



**10** Replace the front covers and reconnect the power cable to the nano pump.

**11** Switch on the nano pump.

# 4
# Parts and Materials

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# Nano Pump Main Assemblies

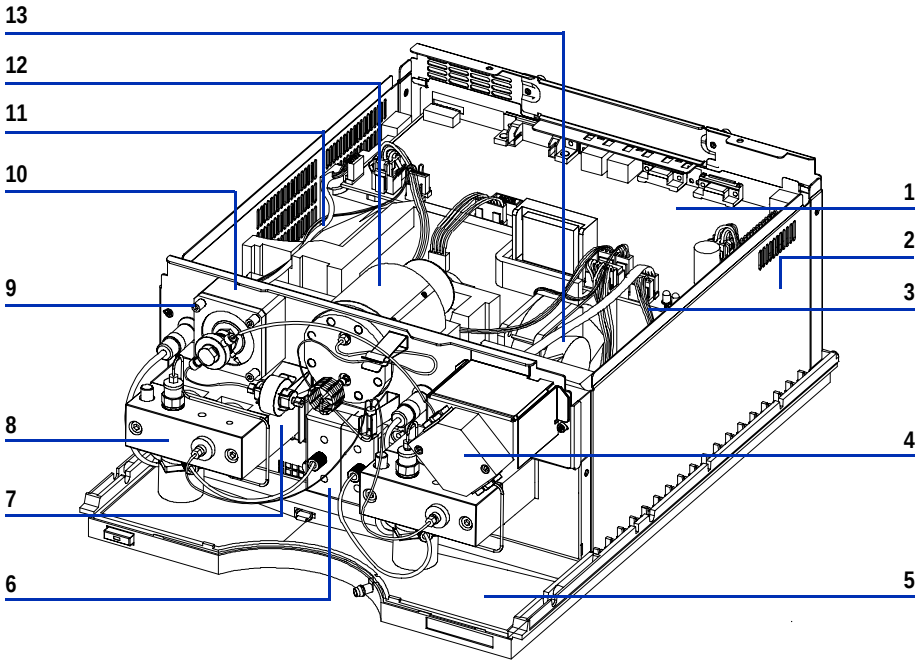



**Figure 25** Nano pump main assembly

**Table 15** Nano pump main assembly

| Item | Description | Part Number |
|---|---|---|
| 1 | Nano pump main board (NPM)<br>Exchange NPM board | G2226-66530<br>G2226-69530 |
| 2 | Power supply | 0950-2528 |
| 3 | Solvent selection valve connecting cable | G1312-61602 |
| 4 | Flow sensor | G1376-60004 |
| 5 | Leak pan - pump | 5041-8390 |
| 6 | Solvent selection valve (half of a complete valve) | G1312-60000 |
| | Solvent selection valve screw | 5022-2112 |
| 7 | Pump drive assembly<br>Exchange pump drive assembly | G1311-60001<br>G1311-69001 |
| 8 | Pump head, see page 163 | G1311-60004 |
| 9 | EMPV holding screw | 0515-0850 |
| 10 | EMPV complete assembly (valve and solenoid) | G1361-60000 |
| 11 | AIV connecting cable | G1311-61601 |
| 12 | Damping unit | 79835-60005 |
| 13 | Fan assembly | 3160-1017 |

# Solvent Cabinet and Bottle-Head Assembly

**Table 16** Solvent cabinet and bottle head assemblies

| Item | Description | Part Number |
|---|---|---|
| | Solvent cabinet assembly includes items 6, 7, 8 | 5062-8581 |
| 1 | Solvent tubing 5 m | 5062-2483 |
| 2 | Tube screw (pack of 10) | 5063-6599 |
| 3 | Ferrules with lock ring (pack of 10) | 5063-6598 |
| 4 | Bottle amber<br>Bottle transparent | 9301-1450<br>9301-1420 |
| 5 | Solvent inlet filter (SST) | 01018-60025 |
| 6 | Leak pan, solvent cabinet | 5042-1307 |
| 7 | Front panel, solvent cabinet | 5062-8580 |
| 8 | Name plate, Agilent 1100 | 5042-1381 |
| | Bottle-head assembly includes items 1, 2, 3, 5 * | G1311-60003 |

* The assy comes with a glass solvent inlet filter. Remove and replace it with the SST solvent inlet frit (01018-60025)

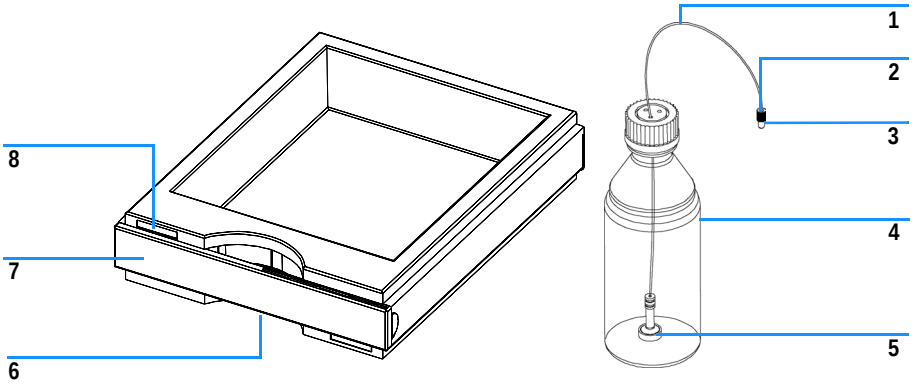



**Figure 26** Solvent cabinet and bottle head assembly

# Nano Pump Hydraulic Path

**Table 17** Nano pump hydraulic path

| Item | Description | Part Number |
|---|---|---|
| 1 | EMPV to FS cap (220 mm, 25 µm) *for nanoflow sensor* | G1375-87321 |
| 2 | Outlet ball valve to piston 2 capillary | G1312-67300 |
| 3 | FS to inj valve cap (350 mm, 25 µm) *for nanoflow sensor*<br>FS to inj valve cap (550 mm, 25 µm) *for nanoflow sensor* | G1375-87322<br>G1375-87323 |
| 4 | Mixing capillary | G1312-67302 |
| 5 | Connection tube | G1311-67304 |
| 6 | Restriction capillary | G1312-67304 |
| 7 | Filter assembly (includes frit)<br>Frit | 5064-8273<br>5022-2185 |
| 8 | Filter to EMPV cap (280 mm, 170 µm) | G1375-87400 |
| 9 | Damper to filter capillary (130 mm, 250 µm) | 01090-87308 |
| 10 | Solvent tube (pack of 4) | G1322-67300 |
| | Corrugated waste tube, 120 cm (re-order 5 m) | 5062-2463 |

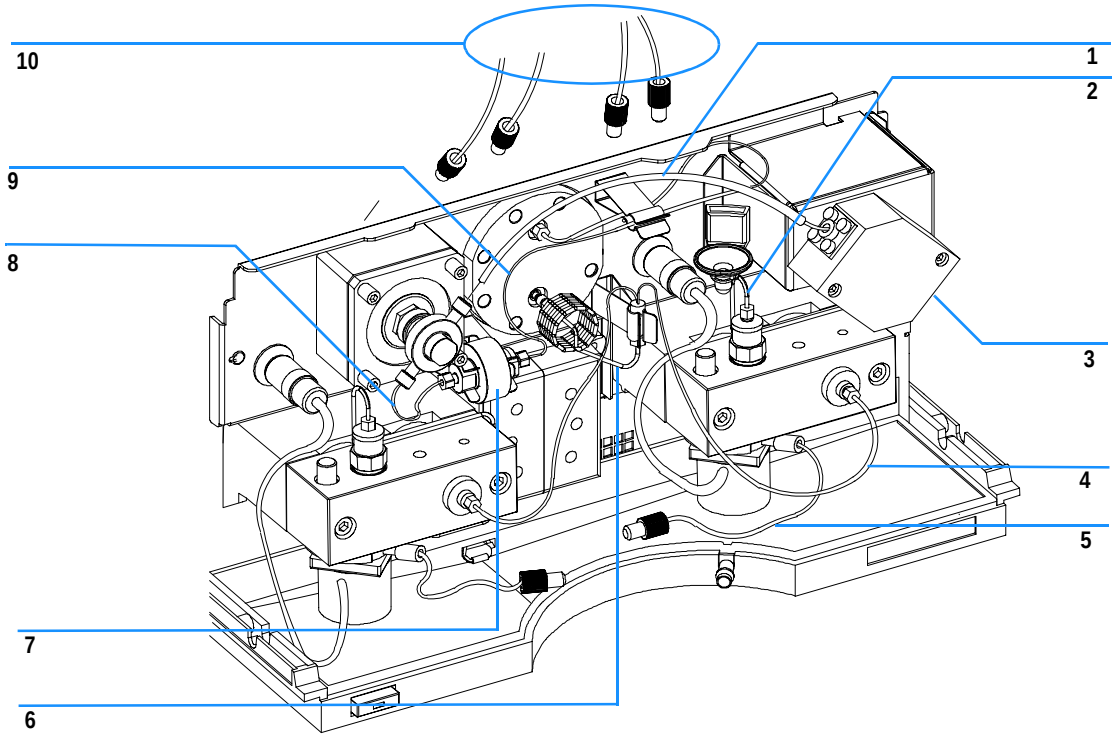



**Figure 27** Nano pump hydraulic path

# Pump-Head Assembly

**Table 18** Pump-Head Assembly

| Item | Description | Part Number |
|---|---|---|
| | Pumphead assembly, included items marked with (*) | G1311-60004 |
| 1 | Outlet ball valve | G1312-60012 |
| 2 | Screw lock | 5042-1303 |
| 3 | Screw M5, 60 mm | 0515-2118 |
| 4 | Apdater | G1312-23201 |
| 5 | Pump chamber housing | G1311-25200 |
| 6 | Active inlet valve (complete with cartridge)<br>Replacement cartridge for active inlet valve | G1312-60010<br>5062-8562 |
| 7 | Seal (pack of 2)<br>Seal (pack of 2), for normal phase applications | 5063-6589<br>0905-1420 |
| 8 | Plunger housing (including springs) | G1311-60002 |
| 9 | Sapphire plunger | 5063-6586 |
| 10 | Support ring | 5001-3739 |
| 11 | Outlet valve to piston 2 capillary | G1312-67300 |

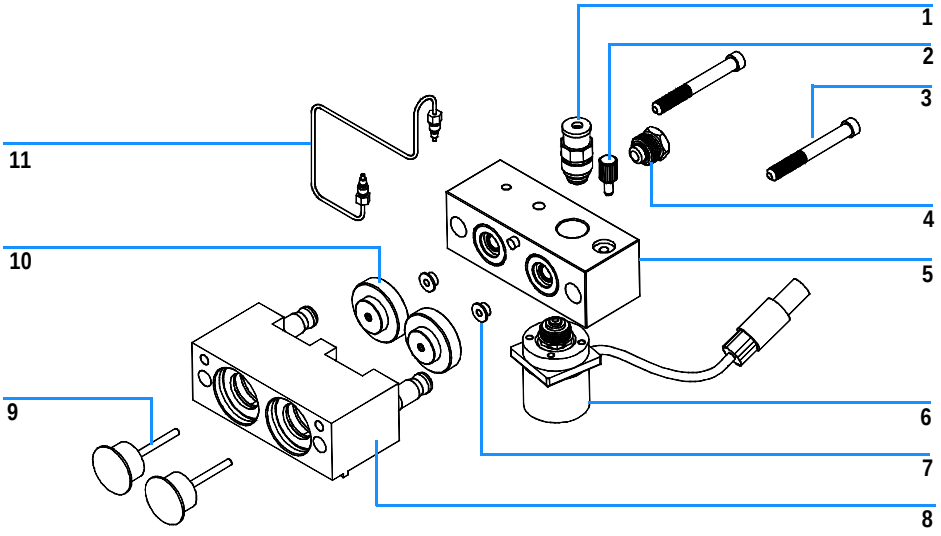



**Figure 28** Pump-Head Assembly

# Electro Magnetic Proportional Valve (EMPV)

**Table 19** EMPV Assembly

| Item | Description | Part Number |
|---|---|---|
| 1 | EMPV — complete assembly | G1361-60000 |
| 2 | Filter to EMPV capillary | G1375-87400 |
| 3 | EMPV to flow sensor capillary (nanoflow sensor) | G1375-87321 |
| 4 | Screw | 0515-0850 |

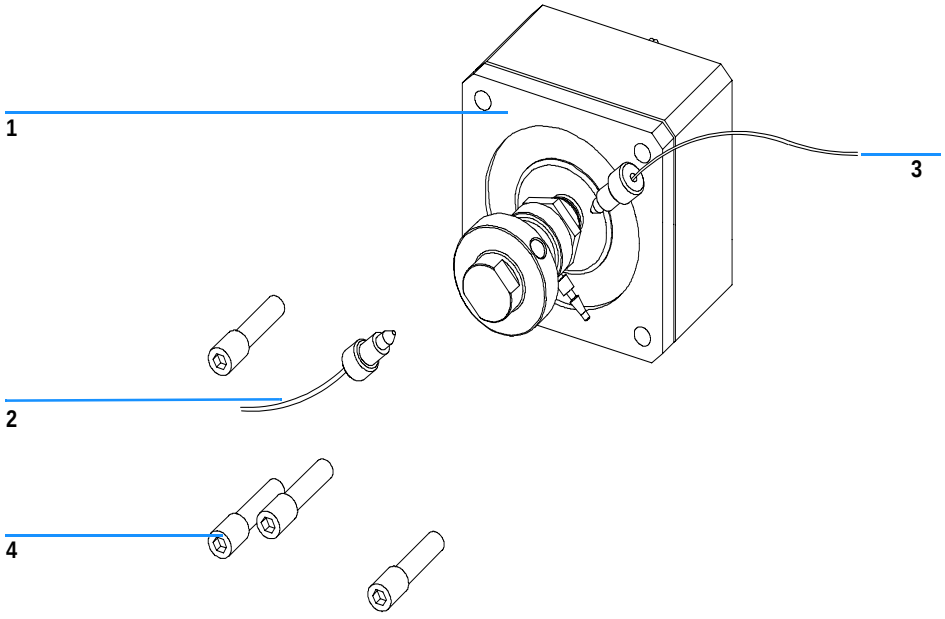



**Figure 29** EMPV Assembly

# Flow Sensor Assembly

**Table 20** Flow Sensor Assembly

| Item | Description | Part Number |
|---|---|---|
| 1 | Nanoflow sensor assembly | G1376-60004 |
| | EMPV to flow sensor capillary (nanoflow sensor) | G1375-87321 |
| | FS to inj valve cap (350 mm, 25 µm) *for nanoflow sensor*<br>FS to inj valve cap (550 mm, 25 µm) *for nanoflow sensor* | G1375-87322<br>G1375-87323 |

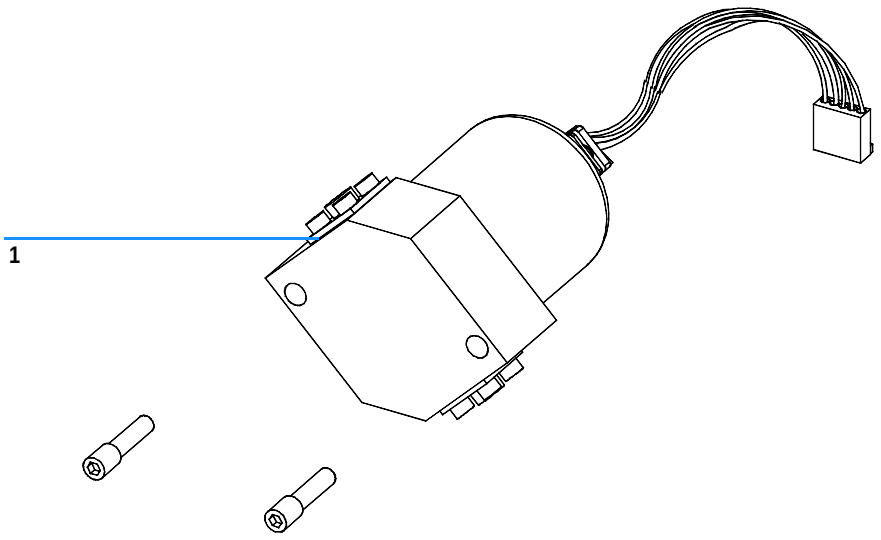



**Figure 30** Flow Sensor Assembly

# Power and Status Light Pipes

**Table 21** Power and Status Light Pipes

| Item | Description | Part Number |
|---|---|---|
| 1 | **Light pipe — power switch** | 5041-8382 |
| 2 | **Power switch coupler** | 5041-8383 |
| 3 | **Light pipe — status lamp** | 5041-8384 |
| 4 | **Power switch button** | 5041-8381 |

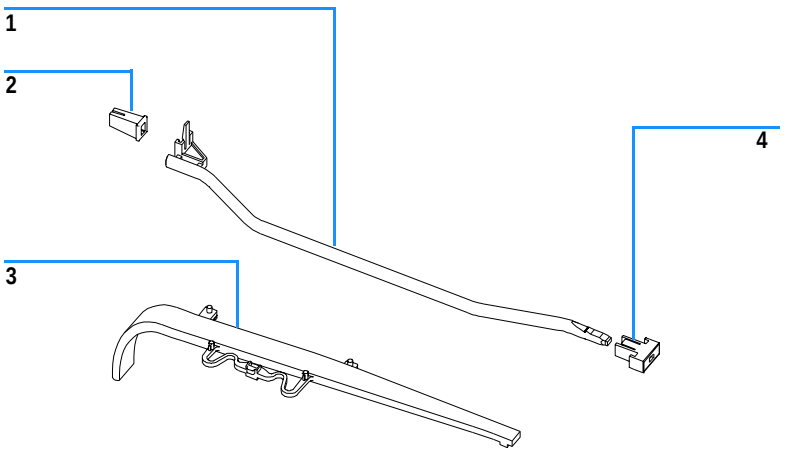



**Figure 31** Power and Status Light Pipes

# Leak Parts

**Table 22** Leak Parts

| Item | Description | Part Number |
|---|---|---|
| 1 | Holder, leak funnel | 5041-8389 |
| 2 | Leak funnel | 5041-8388 |
| 3 | Tube clip | 5041-8387 |
| 4 | Leak plane, pump | 5041-8390 |
| 5 | Leak sensor | 5061-3356 |
| 6 | Corrugated waste tube (reorder pack), 5m | 5062-2463 |

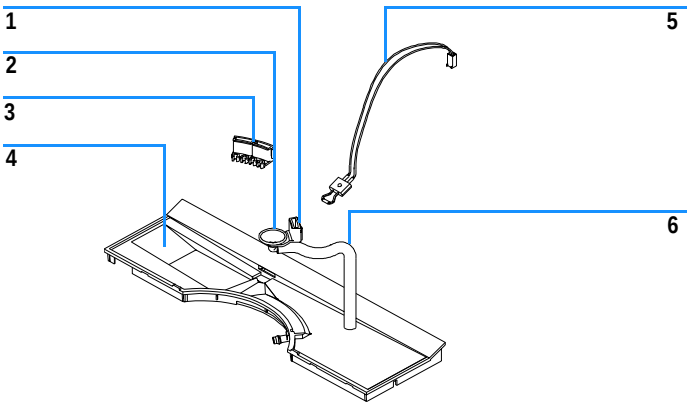



**Figure 32** Leak Parts

# Cover Parts

**Table 23** Cover Parts

| Item | Description | Part Number |
|---|---|---|
| 1 | Plastic cover kit (includes top, base and both sides) | G1312-68703 |
| 2 | Front plate | G1376-60011 |
| 3 | Logo plate, Agilent 1100 | 5042-1381 |

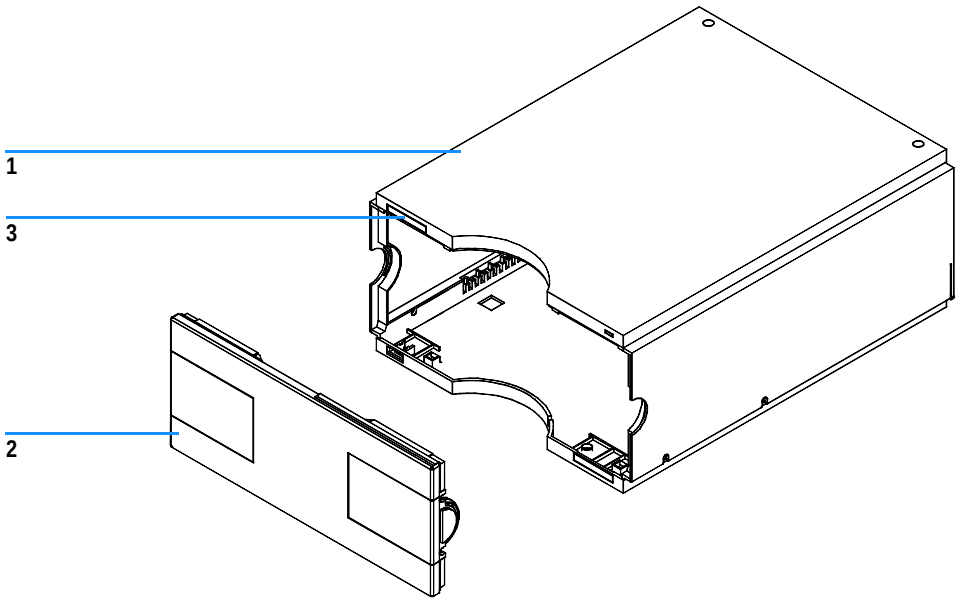



**Figure 33** Cover Parts

# Sheet Metal Kit

**Table 24** Sheet Metal Kit

| Item | Description | Part Number |
|---|---|---|
| 1 | Sheet metal kit, includes top, base and Z-panel | G1376-68701 |
| 2* | Screw, for cover and Z-Panel | 5022-2112 |
| 3* | Board cover | 5001-3772 |

* Included in item 1

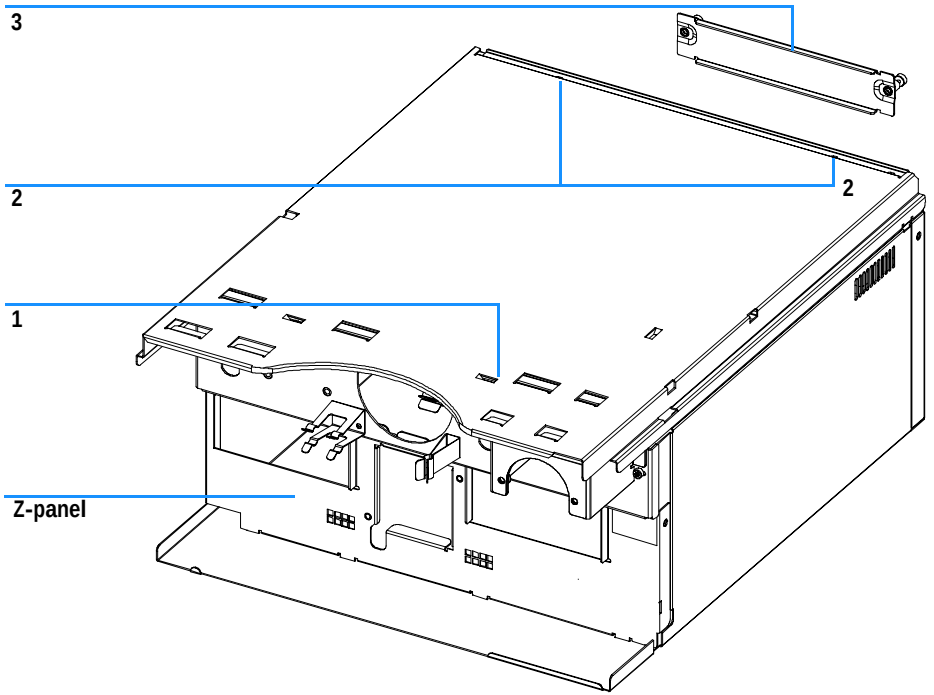



**Figure 34** Sheet Metal Kit

# Foam Parts

**Table 25** Foam Parts

| Item | Description | Part Number |
|---|---|---|
| 1 | Foam kit, including upper and lower foam | G1312-68702 |
| 2 | Bushing, for pump drive | 1520-0404 |
| 3 | Board guide | 5041-8395 |

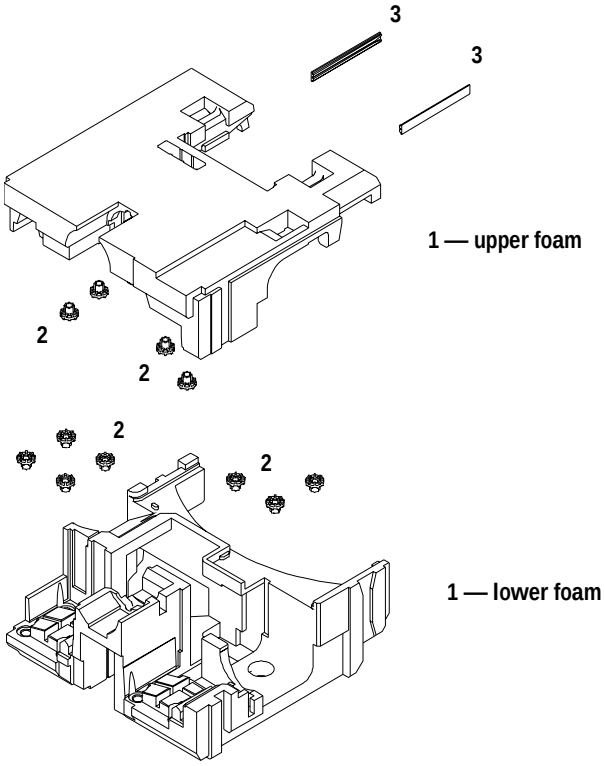



**Figure 35** Foam Parts

# Nano Pump Accessory Kit G2226-68705

**Table 26** Nano Pump Accessory Kit Content G2226-68705

| Description | Part Number |
|---|---|
| Insert tool | 01018-23702 |
| SST Solvent inlet filter (x4) | 01018-60025 |
| Waste tube (2 m) | 0890-1760 |
| SST replacement frit (0.5 µm) | 5022-2185 |
| Wrench open end 7/16 - 1/2 inch (x 2) | 8710-0806 |
| Wrench open end 1/4 - 5/16 inch (x1) | 8710-0510 |
| Wrench open end 14 mm (x 1) | 8710-1924 |
| Wrench open end 4 mm, (x 1) | 8710-1534 |
| Hex key 2.5 mm, 15 cm long, straight handle (x 1) | 8710-2412 |
| Hex key 3.0 mm, 12 cm long (x 1) | 8710-2411 |
| Hex key 4.0 mm, 15 cm long, T handle (x 1) | 8710-2392 |
| Torque adapter | G1315-45003 |
| CAN cable (1 m long) | 5181-1519 |
| Purge valve assembly | G1311-60009 |
| Purge valve holder | G1312-23200 |
| Screw for the purge valve holder | 0515-0175 |
| FS to Inj valve cap. (350 mm, 25 µm) | G1375-87322 |
| FS to Inj valve cap. (550 mm, 25 µm) | G1375-87323 |
| Flow sensor accuracy calibration capillary (8000 mm, 25 µm) | G2226-67300 |
| ESD wrist strap | 9300-1408 |

# Control Module (G1323B)

**Table 27** Control Module Parts

| Item | Description | Part Number |
|---|---|---|
| | Control Module, replacement part including cable | G1323-67001 |
| | Plastic Housing Kit, includes front, back and a clamp | 5062-8583 |
| | CAN cable Agilent 1100 module to control module | G1323-81600 |

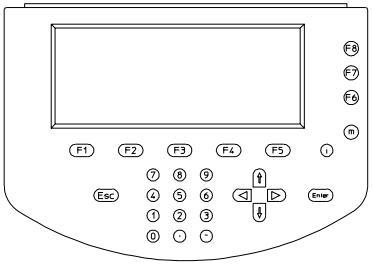



**Figure 36** Control Module

# Cable Overview

**WARNING** **Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.**

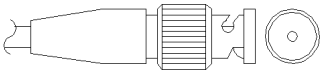
**Table 28** Cables Overview

| Type | Description | Part Number |
|---|---|---|
| Analog cables | 3390/2/3 integrators | 01040-60101 |
| | 3394/6 integrators | 35900-60750 |
| | Agilent 35900A A/D converter | 35900-60750 |
| | General purpose (spade lugs) | 01046-60105 |
| Remote cables | 3390 integrator | 01046-60203 |
| | 3392/3 integrators | 01046-60206 |
| | 3394 integrator | 01046-60210 |
| | 3396A (Series I) integrator | 03394-60600 |
| | 3396 Series II / 3395A integrator, see page 181 | |
| | 3396 Series III / 3395B integrator | 03396-61010 |
| | HP 1050 modules / HP 1046A FLD | 5061-3378 |
| | HP 1046A FLD | 5061-3378 |
| | Agilent 35900A A/D converter | 5061-3378 |
| | HP 1040 diode-array detector | 01046-60202 |
| | HP 1090 liquid chromatographs | 01046-60202 |
| | Signal distribution module | 01046-60202 |
| **BCD cables** | 3392/3 integrators<br>(not possible with the well plate samplers) | 18594-60510 |

**Table 28** Cables Overview, continued, continued

| Type | Description | Part Number |
|---|---|---|
| | 3396 integrator<br>(not possible with the well plate samplers) | 03396-60560 |
| | General purpose (spade Lugs) | G1351-81600 |
| **Auxiliary** | Agilent 1100 Series vacuum degasser | G1322-61600 |
| **CAN cables** | Agilent 1100 module to module,0.5m lg<br>Agilent 1100 module to module, 1m lg | 5181-1516<br>5181-1519 |
| | Agilent 1100 module to control module | G1323-81600 |
| **External contacts** | Agilent 1100 Series interface board to general purpose | G1103-61611 |
| **GPIB cable** | Agilent 1100 module to ChemStation, 1 m | 10833A |
| | Agilent 1100 module to ChemStation, 2 m | 10833B |
| **RS-232 cable** | Agilent 1100 module to a computer<br>This kit contains a 9-pin female to 9-pin female Null Modem (printer) cable and one adapter. | 34398A |
| **LAN cable** | Twisted pair cross over LAN cable, 10 feet long<br>(for point to point connection) | 5183-4649 |
| | Category 5 UTP cable, 8 m long<br>(for hub connections) | G1530-61480 |

# Analog Cables



One end of these cables provides a BNC connector to be connected to Agilent 1100 Series modules. The other end depends on the instrument to which connection is being made.

**Table 29** Agilent 1100 to 3390/2/3 Integrators

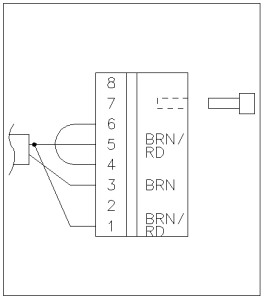
| Connector 01040-60101 | Pin 3390/2/3 | Pin Agilent 1100 | Signal Name |
|---|---|---|---|
|  | 1 | Shield | Ground |
| | 2 | | Not connected |
| | 3 | Center | Signal + |
| | 4 | | Connected to pin 6 |
| | 5 | Shield | Analog - |
| | 6 | | Connected to pin 4 |
| | 7 | | Key |
| | 8 | | Not connected |

**Table 30** Agilent 1100 to 3394/6 Integrators

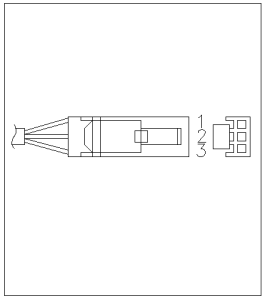
| Connector 35900-60750 | Pin 3394/6 | Pin Agilent 1100 | Signal Name |
|---|---|---|---|
|  | 1 | | Not connected |
| | 2 | Shield | Analog - |
| | 3 | Center | Analog + |



**Table 31** Agilent 1100 to BNC Connector

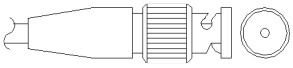
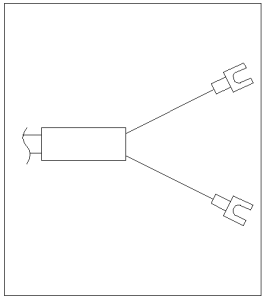
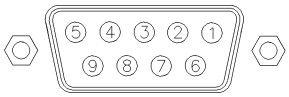
| Connector 8120-1840 | Pin BNC | Pin Agilent 1100 | Signal Name |
|---|---|---|---|
| | Shield | Shield | Analog - |
|  | Center | Center | Analog + |

**Table 32** Agilent 1100 to General Purpose

| Connector 01046-60105 | Pin 3394 / 6 | Pin Agilent 1100 | Signal Name |
|---|---|---|---|
|  | 1 | | Not connected |
| | 2 | Black | Analog - |
| | 3 | Red | Analog + |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Remote Cables




One end of these cables provides a Agilent Technologies APG (Analytical Products Group) remote connector to be connected to Agilent 1100 Series modules. The other end depends on the instrument to be connected to.

**Table 33** Agilent 1100 to 3390 Integrators

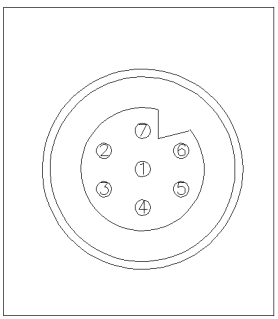
| Connector 01046-60203 | Pin 3390 | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | 2 | 1 - White | Digital ground | |
| | NC | 2 - Brown | Prepare run | Low |
| | 7 | 3 - Gray | Start | Low |
| | NC | 4 - Blue | Shut down | Low |
| | NC | 5 - Pink | Not connected | |
| | NC | 6 - Yellow | Power on | High |
| | NC | 7 - Red | Ready | High |
| | NC | 8 - Green | Stop | Low |
| | NC | 9 - Black | Start request | Low |

**Table 34** Agilent 1100 to 3392/3 Integrators

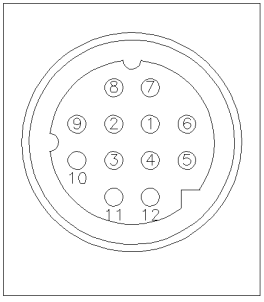
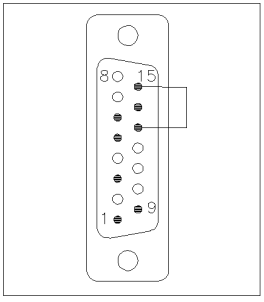
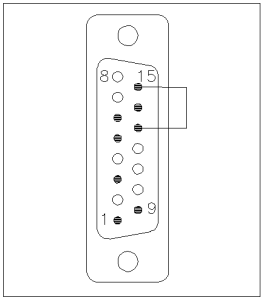
| Connector 01046-60206 | Pin 3392/3 | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | 3 | 1 - White | Digital ground | |
| | NC | 2 - Brown | Prepare run | Low |
| | 11 | 3 - Gray | Start | Low |
| | NC | 4 - Blue | Shut down | Low |
| | NC | 5 - Pink | Not connected | |
| | NC | 6 - Yellow | Power on | High |
| | 9 | 7 - Red | Ready | High |
| 4 - Key | 1 | 8 - Green | Stop | Low |
| | NC | 9 - Black | Start request | Low |

**Table 35** Agilent 1100 to 3394 Integrators

| Connector 01046-60210 | Pin 3394 | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | 9 | 1 - White | Digital ground | |
| | NC | 2 - Brown | Prepare run | Low |
| | 3 | 3 - Gray | Start | Low |
| | NC | 4 - Blue | Shut down | Low |
| | NC | 5 - Pink | Not connected | |
| | NC | 6 - Yellow | Power on | High |
| | 5,14 | 7 - Red | Ready | High |
| | 6 | 8 - Green | Stop | Low |
| | 1 | 9 - Black | Start request | Low |
| | 13, 15 | | Not connected | |

NOTE START and STOP are connected via diodes to pin 3 of the 3394 connector.

**Table 36** Agilent 1100 to 3396A Integrators

| Connector 03394-60600 | Pin 3394 | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | 9 | 1 - White | Digital ground | |
| | NC | 2 - Brown | Prepare run | Low |
| | 3 | 3 - Gray | Start | Low |
| | NC | 4 - Blue | Shut down | Low |
| | NC | 5 - Pink | Not connected | |
| | NC | 6 - Yellow | Power on | High |
| | 5,14 | 7 - Red | Ready | High |
| | 1 | 8 - Green | Stop | Low |
| | NC | 9 - Black | Start request | Low |
| | 13, 15 | | Not connected | |



### Agilent 1100 to 3396 Series II / 3395A Integrators

Use the cable 03394-60600 and cut pin #5 on the integrator side. Otherwise the integrator prints START; not ready.

**Table 37** Agilent 1100 to 3396 Series III / 3395B Integrators

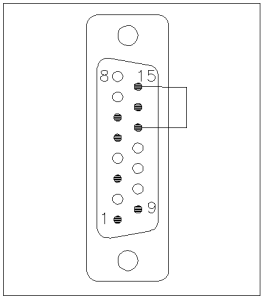
| Connector 03396-61010 | Pin 33XX | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | 9 | 1 - White | Digital ground | |
| | NC | 2 - Brown | Prepare run | Low |
| | 3 | 3 - Gray | Start | Low |
| | NC | 4 - Blue | Shut down | Low |
| | NC | 5 - Pink | Not connected | |
| | NC | 6 - Yellow | Power on | High |
| | 14 | 7 - Red | Ready | High |
| | 4 | 8 - Green | Stop | Low |
| | NC | 9 - Black | Start request | Low |
| | 13, 15 | | Not connected | |

**Table 38** Agilent 1100 to HP 1050, HP 1046A or Agilent 35900 A/D Converters

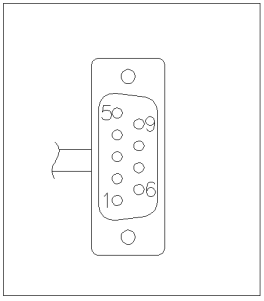
| Connector 5061-3378 | Pin HP 1050 / .... | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | 1 - White | 1 - White | Digital ground | |
| | 2 - Brown | 2 - Brown | Prepare run | Low |
| | 3 - Gray | 3 - Gray | Start | Low |
| | 4 - Blue | 4 - Blue | Shut down | Low |
| | 5 - Pink | 5 - Pink | Not connected | |
| | 6 - Yellow | 6 - Yellow | Power on | High |
| | 7 - Red | 7 - Red | Ready | High |
| | 8 - Green | 8 - Green | Stop | Low |
| | 9 - Black | 9 - Black | Start request | Low |

**Table 39** Agilent 1100 to HP 1090 LC, HP 1040 DAD or Signal Distribution Module

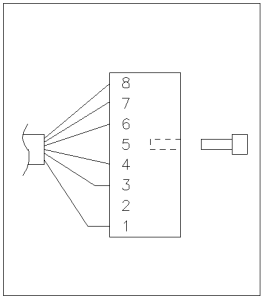
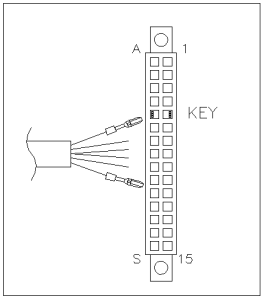
| Connector 01046-60202 | Pin HP 1090 | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  5 - Key | 1 | 1 - White | Digital ground | |
| | NC | 2 - Brown | Prepare run | Low |
| | 4 | 3 - Gray | Start | Low |
| | 7 | 4 - Blue | Shut down | Low |
| | 8 | 5 - Pink | Not connected | |
| | NC | 6 - Yellow | Power on | High |
| | 3 | 7 - Red | Ready | High |
| | 6 | 8 - Green | Stop | Low |
| | NC | 9 - Black | Start request | Low |

**Table 40** Agilent 1100 to General Purpose

| Connector 01046-60201 | Pin Universal | Pin Agilent 1100 | Signal Name | Active (TTL) |
|---|---|---|---|---|
|  | | 1 - White | Digital ground | |
| | | 2 - Brown | Prepare run | Low |
| | | 3 - Gray | Start | Low |
| | | 4 - Blue | Shut down | Low |
| | | 5 - Pink | Not connected | |
| | | 6 - Yellow | Power on | High |
| | | 7 - Red | Ready | High |
| | | 8 - Green | Stop | Low |
| | | 9 - Black | Start request | Low |

# BCD Cables

One end of these cables provides a 15-pin BCD connector to be connected to the Agilent 1100 Series modules. The other end depends on the instrument to be connected to.

NOTE The BCD output for the well plate sampler does not work with the integrators 3392/3/6.

**Table 41** Agilent 1100 to 3392/3 Integrators

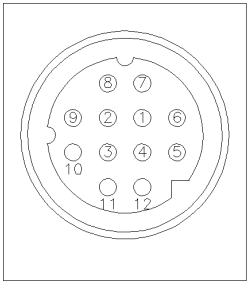
| Connector 18584-60510 | Pin 3392/3 | Pin Agilent 1100 | Signal Name | BCD Digit |
|---|---|---|---|---|
|  6 - Key | 10 | 1 | BCD 5 | 20 |
| | 11 | 2 | BCD 7 | 80 |
| | 3 | 3 | BCD 6 | 40 |
| | 9 | 4 | BCD 4 | 10 |
| | 7 | 5 | BCD 0\ | 1 |
| | 5 | 6 | BCD 3 | 8 |
| | 12 | 7 | BCD 2 | 4 |
| | 4 | 8 | BCD 1 | 2 |
| | 1 | 9 | Digital ground | |
| | 2 | 15 | + 5 V | Low |

**Table 42** Agilent 1100 to 3396 Integrators

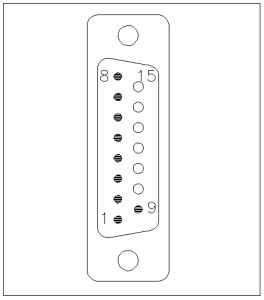
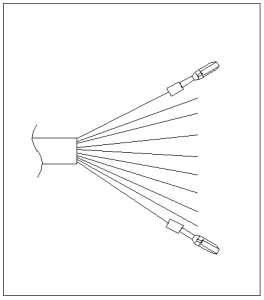
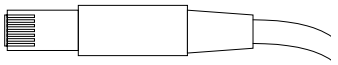
| Connector 03396-60560 | Pin 3392 / 3 | Pin Agilent 1100 | Signal Name | BCD Digit |
|---|---|---|---|---|
|  | 1 | 1 | BCD 5 | 20 |
| | 2 | 2 | BCD 7 | 80 |
| | 3 | 3 | BCD 6 | 40 |
| | 4 | 4 | BCD 4 | 10 |
| | 5 | 5 | BCD 0\ | 1 |
| | 6 | 6 | BCD 3 | 8 |
| | 7 | 7 | BCD 2 | 4 |
| | 8 | 8 | BCD 1 | 2 |
| | 9 | 9 | Digital ground | |
| | NC | 15 | + 5 V | Low |

**Table 43** Agilent 1100 to General Purpose

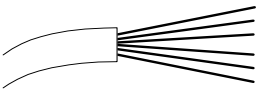
| Connector G1351-81600 | Wire Color | Pin Agilent 1100 | Signal Name | BCD Digit |
|---|---|---|---|---|
|  | Green | 1 | BCD 5 | 20 |
| | Violet | 2 | BCD 7 | 80 |
| | Blue | 3 | BCD 6 | 40 |
| | Yellow | 4 | BCD 4 | 10 |
| | Black | 5 | BCD 0\ | 1 |
| | Orange | 6 | BCD 3 | 8 |
| | Red | 7 | BCD 2 | 4 |
| | Brown | 8 | BCD 1 | 2 |
| | Gray | 9 | Digital ground | |
| | Gray/Pink | 10 | BCD 11 | 100 |
| | Red/Blue | 11 | BCD 10 | 200 |
| | White/Green | 12 | BCD 9 | 400 |
| | Brown/Green | 13 | BCD 8 | 800 |
| | | 14 | n/c | |
| | | 15 | n/c | |

# Auxiliary Cable

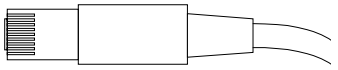


One end of this cable provides a modular plug to be connected to the Agilent 1100 Series vacuum degasser. The other end is for general purpose.

**Table 44** Agilent 1100 Series Degasser to general purposes

| Connector G1322-81600 | Color | Pin Agilent 1100 | Signal Name |
|---|---|---|---|
|  | White | 1 | Ground |
| | Brown | 2 | Pressure signal |
| | Green | 3 | |
| | Yellow | 4 | |
| | Grey | 5 | DC + 5 V IN |
| | Pink | 6 | Vent |

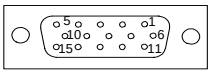
# CAN Cable



Both ends of this cable provide a modular plug to be connected to Agilent 1100 Series module's CAN-bus connectors.

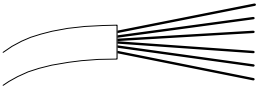
| | |
|---|---|
| Agilent 1100 module to module, 0.5m lg | 5181-1516 |
| Agilent 1100 module to module, 1m lg | 5181-1519 |
| Agilent 1100 module to control module | G1323-81600 |

# External Contact Cable




One end of this cable provides a 15-pin plug to be connected to Agilent 1100 Series module's interface board. The other end is for general purpose.

**Table 45** Agilent 1100 Series Interface Board to general purposes

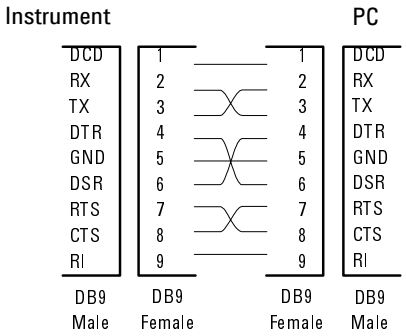
| Connector G1103-61611 | Color | Pin Agilent 1100 | Signal Name |
|---|---|---|---|
|  | White | 1 | EXT 1 |
| | Brown | 2 | EXT 1 |
| | Green | 3 | EXT 2 |
| | Yellow | 4 | EXT 2 |
| | Grey | 5 | EXT 3 |
| | Pink | 6 | EXT 3 |
| | Blue | 7 | EXT 4 |
| | Red | 8 | EXT 4 |
| | Black | 9 | Not connected |
| | Violet | 10 | Not connected |
| | Grey/pink | 11 | Not connected |
| | Red/blue | 12 | Not connected |
| | White/green | 13 | Not connected |
| | Brown/green | 14 | Not connected |
| | White/yellow | 156 | Not connected |

# RS-232 Cable Kit

This kit contains a 9-pin female to 9-pin female Null Modem (printer) cable and one adapter. Use the cable and adapter to connect Agilent Technologies instruments with 9-pin male RS-232 connectors to most PCs or printers.

### Agilent 1100 module to PC

**Table 46** RS-232 Cable Kit 34398A



# LAN Cables

### Recommended Cables

For point to point connection (not using a network hub) use a twisted pair cross over LAN cable (P/N 5183-4649, 10 feet long).

For standard network connections using a hub use category 5 UTP cables, (P/N G1530-61480, 8 m long).

# 5 Introduction to the Nano Pump

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The Main Power Supply Assembly 228

# Introduction to the Nano Pump

The nano pump consists of two identical pumping units in a single housing. It generates gradients by high-pressure mixing. A solvent selection valve provides flexibility in the choice of solvents.

Mobile phase composition is produced by mixing the outputs of pump A and pump B. The solvent selection valve allows the pump A output to originate from either channel A1 or channel A2. The pump B output may originate from either channel B1 or channel B2.

The primary flow produced by the two pumping units is proportioned in an electomagnetical proportional valve (EMPV). The remaining column flow is measured in a mass flow sensitive flow sensor. The measured flow is compared with the user-entered column flow setpoint. The flow sensor controls the EMPV current, causing the EMPV to correctly proportion the column flow. The primary flow in excess of the required column flow volume is derivated to the waste.

Solvent degassing is not done directly in the pump. A 4-channel, low volume micro vacuum degasser, available as a separate module, provides degassed solvents to the pump channel inputs. Solvent degassing is required for best flow stability and detector stability, especially at the low flow rates required to run nano LC applications.

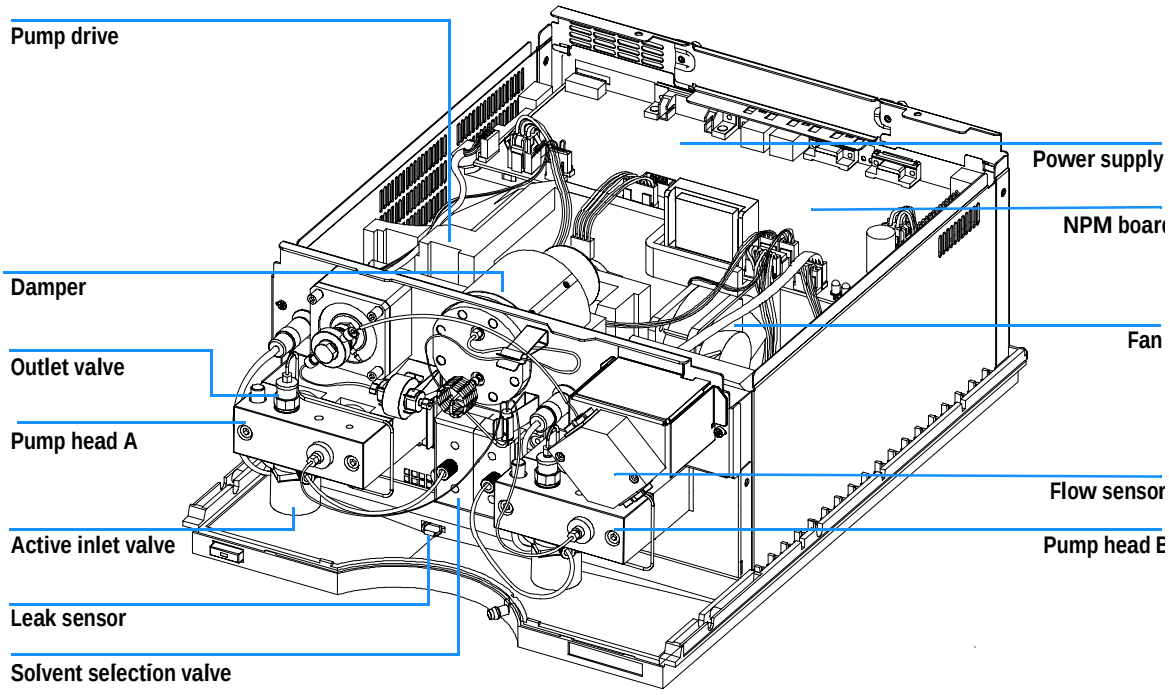



**Figure 37** Overview of the Nano Pump

## Hydraulic Path Overview

The nano pump is based on the Agilent 1100 binary pump, and performs all the functions necessary for a nano flow solvent delivery system. Basically, these functions are:

- Low Pressure Metering and High Pressure Delivery
- Solvent Compressibility Compensation
- Variable Stroke Volume
- Column Flow Measurement and Control

Low pressure solvent metering, and high pressure solvent delivery, are accomplished by two pump channels, each capable of delivering a maximum of 2.5 ml/min flow at up to 400 bar pressure.

Each channel consists of an identical, independently controlled pump unit Each pump unit includes a pump metering drive assembly and pump head assembly. The pamphlet assemblies both consist of two identical chambers, pistons and seals, plus an active inlet valve and an outlet ball valve.

The channel flow outputs are initially joined by a low volume pre-mixer, and are then connected by a capillary coil to a pressure pulse damper. The pressure pulse damper also serves as a pressure transducer, which sends system pressure information to the user interface.

This output flow, called primary flow, is connected to the Electronic Flow Control (EFC) system. The EFC system consists of an Electro-Magnetic Proportioning Valve (EMPV) in series with a Flow Sensor. The EMPV is protected from particles in the mobile phase by a solvent filter frit. Responding to user-entered column flow setpoint, the EFC system determines how much of the main flow volume is ultimately delivered to the column. The remaining main flow volume, which is not required by the column, is diverted to waste by the EMPV.

Under user control, the EMPV can also function as a purge valve, for purposes of solvent changeover, etc. In this case, the EMPV is totally open, and the total main flow is diverted to waste.

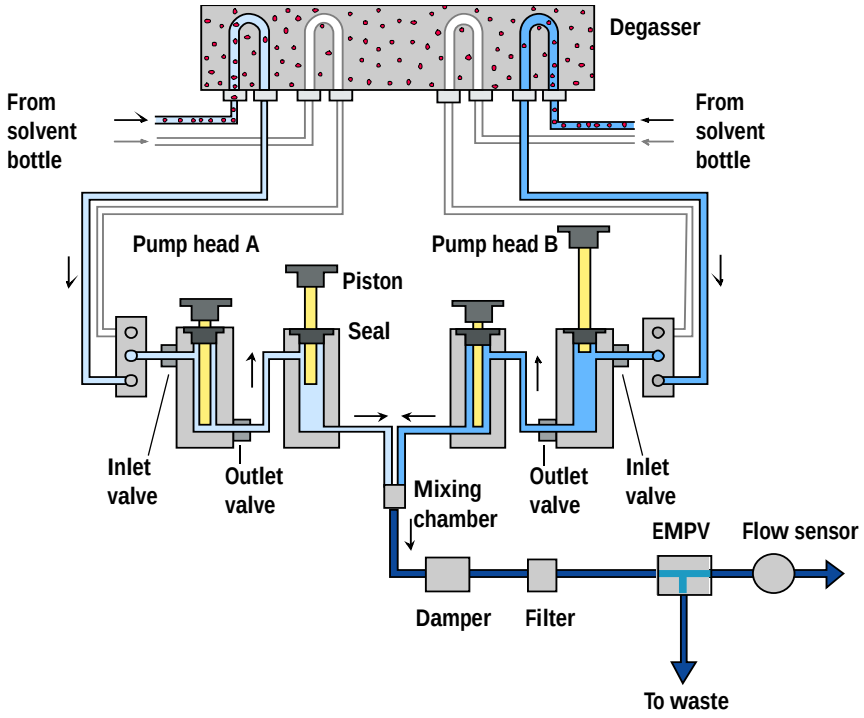



**Figure 38** The Hydraulic Path

## How Does the Pumping unit Work?

Both pumping units (channel A and channel B) are identical with respect to parts and function. Each pumping unit consists of a pump head which is directly attached to a metering drive assembly.

In each metering drive assembly, a servo-controlled variable reluctance motor and gear train assembly are used to move two ball-screw drives. The gear train moves the two ball-screw drives in opposite directions (180 degree out of phase). The gear ratios are designed such that the first ball-screw drive constantly moves at twice the speed of the second ball-screw drive. The servo motor includes a high resolution shaft-position encoder, which continuously reports the speed and direction of the motor in real time. This speed and direction information is used by the pump control electronics to ensure precise control of the servo motor movement.

Each pump head consists of two identical chambers, pistons and seals, plus an active inlet valve and an outlet ball valve. The solvent volume in each chamber is displaced by its piston. The pistons are directly moved by the reciprocating ball-screw drives of the metering drive assembly. Due to the gear design of the metering drive assembly, the pistons move in opposite directions, with piston 1 constantly moving at twice the speed of piston 2. The outer diameter of the piston is smaller than the inner diameter of the chamber, allowing solvent to flow in the gap between the piston and the chamber wall. The two chambers are connected by the pressure dependent outlet ball valve.

The position of the solvent selection valve determines which of two solvents will be sucked (low pressure) through the active inlet valve into chamber 1 during the intake stroke of piston 1. The active inlet valve is electrically opened and closed, making its operation more precise at low pressures. The stroke volume of piston 1 is between 2 µl and 100 µl, depending on flow rate.

When the nano pump is first turned on, the user is prompted to initialize the pump. The initialization routine (occurring for both pump heads) first determines the precise movement limits for both pistons.These limits are then stored in the pump controller memory. Then, both pistons are set to their default initial positions.

When pumping begins, the active inlet valve is opened and piston 1 begins its intake stroke, sucking solvent into chamber 1. At the same time, piston 2 begins its delivery stroke, pumping (high pressure) the existing solvent in chamber 2 out of the pump head. The pressure produced by piston 2 also closes the outlet ball valve, preventing any chamber 2 solvent from back-streaming into chamber 1. After a predefined piston 1 stroke length, the servo motor is stopped, and the active inlet valve is closed. The pistons now reverse directions. Piston 1 begins its delivery stroke (high pressure), and piston 2 begins its intake stroke. Piston 2 is moving at only half the speed of piston 1. The outlet ball valve is forced open by the pressure generated by piston 1. Piston 1 begins to deliver the volume previously sucked into chamber 1. Because of the 2:1 speed ratio of the pistons, half of the solvent flow from chamber 1 is forced out of the pump head, continuing into the pump hydraulic path. The other half of the flow from chamber 1 simultaneously refills chamber 2.

When piston 1 has completed its delivery stroke, the pistons reverse direction, and the cycle is repeated.

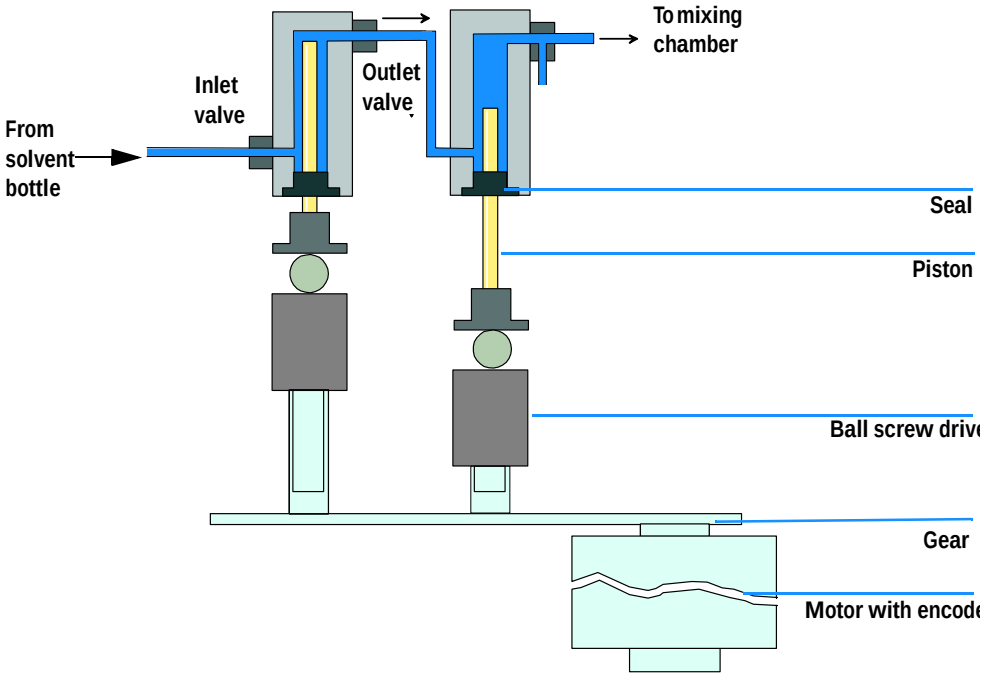



**Figure 39** Operating Principle of the pump head

**Table 47** Nano Pump Details

| | |
|---|---|
| Materials in contact with mobile phase | |
| Pump head | SST, gold, sapphire, ceramic |
| Active Inlet Valve | SST, gold, sapphire, ruby, ceramic, PTFE |
| Outlet Valve | SST, gold, sapphire, ruby, tantalum |
| Adapter | SST, gold |
| EMPV | SST, ruby, sapphire, PEEK |
| Flow Sensor | SST |
| Damping Unit | Gold, SST |
| Capillaries | Fused Silica |

For pump specifications, see “Specifications” on page 257.

### How Does Compressibility Compensation Work?

The compressibility of the solvents in use will affect retention-time stability when the back pressure in the system changes (for example, aging of column). In order to minimize this effect, the pump provides a compressibility compensation feature which optimizes the flow stability according to the solvent type. The compressibility compensation is set to a default value for each pump head independently. The compensation value for each pump head can be changed through the user interface.

Without a compressibility compensation the following will happen during a stroke of the first piston. The pressure in the piston chamber increases and the volume in the chamber will be compressed depending on backpressure and solvent type. The volume displaced into the system will be reduced by the compressed volume.

When a compressibility compensation value for a pump head is set, the pump processor calculates a compensation volume that depends on the system pressure and the selected compressibility value. This compensation volume is added to the delivery stroke of the first piston.

### How Does Variable Stroke Volume Work?

Due to the compression of the pump-chamber volume each piston stroke of the pump will generate a small pressure pulsation, influencing the flow ripple of the pump. The amplitude of the pressure pulsation is mainly dependent on the stroke volume and the compressibility compensation for the solvent in use. Small stroke volumes will generate less pressure pulsations than higher stroke volumes at same flow rates. In addition the frequency of the pressure pulsations will be higher. This will decrease the influence of flow pulsations on quantitative results.

In gradient mode smaller stroke volumes resulting in less flow ripple will improve composition ripple.

The nano pump uses a processor-controlled ball screw system to drive its pistons. The normal stroke volume is optimized for the selected flow rate. Small flow rates use a small stroke volume while higher flow rates use a higher stroke volume.

The stroke volume for the pump is set to AUTO mode. This means that the stroke is optimized for the flow rate in use. A change to larger stroke volumes is possible but not recommended.

When the pump is in the standard mode, the EMPV is fully closed. Total main flow, up to 2500 µl/min, is directed to the LC system. Column flow measurement/control is disabled. This mode is for non-capillary LC applications.

In the micro mode, the flow sensor measures and controls column flow in the range of 0.1 µl/min to 4 µl/min. Flow measurement is based on the principle of mass flow temperature sensitivity. The flow sensor consists of a heated tube with two temperature sensors. As the mobile phase passes through the heated tube, the temperature characteristic distributed over the two temperature sensors is evaluated. From the temperature characteristic, flow rate accuracy is determined. The flow sensor measurement is calibrated for specific mobile phases, which are user-selectable.

# Electrical Connections

- The GPIB connector is used to connect the nano pump with a computer. The address and control switch module next to the GPIB connector determines the GPIB address of your nano pump. The switches are preset to a default address (see Table 51 on page 219) and is recognized once after power on.
- The CAN bus is a serial bus with high-speed data transfer. The two connectors for the CAN bus are used for internal Agilent 1100 Series module data transfer and synchronization.
- One analog output provides a signal for integrators or data handling systems.
- The REMOTE connector may be used in combination with other analytical instruments from Agilent Technologies if you want to use features such as common shut down, prepare, and so on.
- The RS-232 connector may be used to control the nano pump from a computer via RS-232 connection, using appropriate software. This connector needs to be activated by the configuration switch module next to the GPIB connector. The software needs the appropriate drivers to support this communication. See your software documentation for further information.
- The power input socket accepts a line voltage of 100 – 240 volts AC ± 10 % with a line frequency of 50 or 60 Hz. Maximum power consumption is 220 VA (Volt-Amps). There is no voltage selector on your nano pump because the power supply has wide-ranging capability. There are no externally accessible fuses, because automatic electronic fuses are implemented in the power supply. The security lever at the power input socket prevents that the nano pump cover is taken off when line power is still connected.
- The interface board slot is used for external contacts, BCD output, LAN and for future use.

**WARNING** **Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.**

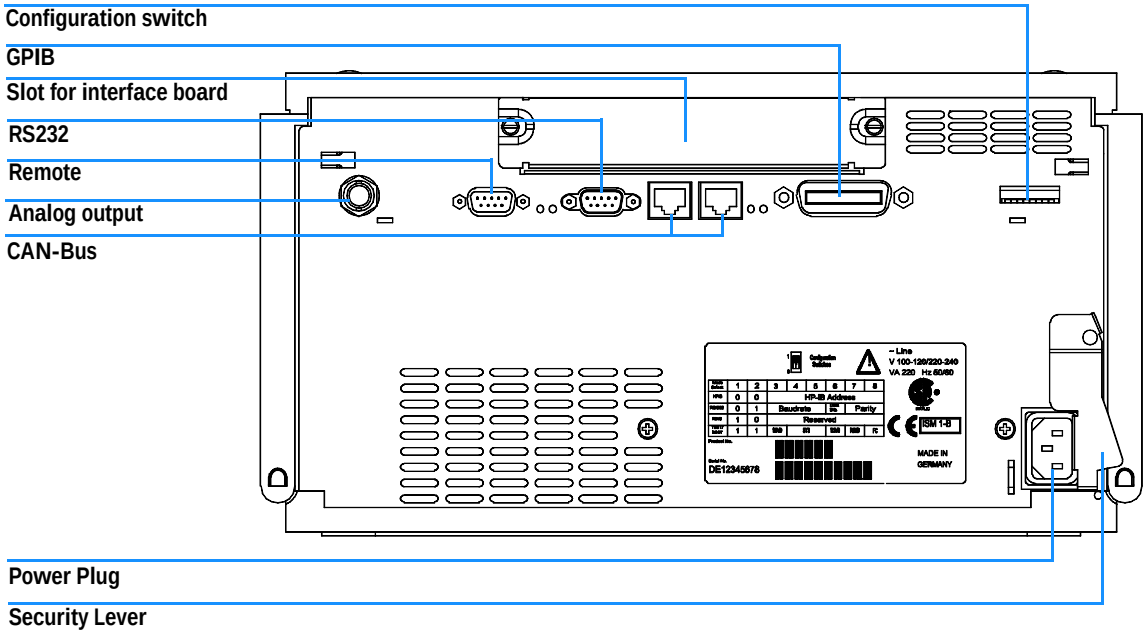



**Figure 40** Electrical Connections to the Nano Pump

**WARNING** **To disconnect the nano pump from line, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.**

# Instrument Layout

The industrial design of the module incorporates several innovative features. It uses Agilent's E-PAC concept for the packaging of electronics and mechanical assemblies. This concept is based upon the use of expanded polypropylene (EPP) layers foam plastic spacers in which the mechanical and electronic boards components of the module are placed. This pack is then housed in a metal inner cabinet which is enclosed by a plastic external cabinet. The advantages of this packaging technology are:

- virtual elimination of fixing screws, bolts or ties, reducing the number of components and increasing the speed of assembly/disassembly,
- the plastic layers have air channels molded into them so that cooling air can be guided exactly to the required locations,
- the plastic layers help cushion the electronic and mechanical parts from physical shock, and
- the metal inner cabinet shields the internal electronics from electromagnetic interference and also helps to reduce or eliminate radio frequency emissions from the instrument itself.

# Early Maintenance Feedback (EMF)

Maintenance requires the exchange of components in the flow path which are subject to mechanical wear or stress. Ideally, the frequency at which components are exchanged should be based on the intensity of usage of the instrument and the analytical conditions, and not on a predefined time interval. The early maintenance feedback (EMF) feature monitors the usage of specific components in the instrument, and provides feedback when the user-settable limits have been exceeded. The visual feedback in the user interface provides an indication that maintenance procedures should be scheduled.

## EMF Counters

The nano pump provides a series of EMF counters for the left and right pump heads. Each counter increments with pump use, and can be assigned a maximum limit which provides visual feedback in the user interface when the limit is exceeded. Each counter can be reset to zero after maintenance has been done. The nano pump provides the following EMF counters:

- liquimeter pump A,
- seal wear pump A,
- liquimeter pump B, and
- seal wear pump B.

### Liquimeters

The liquimeters display the total volume of solvent pumped by the left and right pump heads since the last reset of the counters. Both liquimeters can be assigned an EMF (maximum) limit. When the limit is exceeded, the EMF flag in the user interface is displayed.

### Seal Wear Counters

The seal wear counters display a value derived from pressure and flow (both contribute to seal wear). The values increment with pump usage until the counters are reset after seal maintenance. Both seal wear counters can be assigned an EMF (maximum) limit. When the limit is exceeded, the EMF flag in the user interface is displayed.

## Using the EMF Counters

The user-settable EMF limits for the EMF counters enable the early maintenance feedback to be adapted to specific user requirements. The wear of pump components is dependent on the analytical conditions, therefore, the definition of the maximum limits need to be determined based on the specific operating conditions of the instrument.

### Setting the EMF Limits

The setting of the EMF limits must be optimized over one or two maintenance cycles. Initially, no EMF limit should be set. When performance indicates maintenance is necessary, take note of the values displayed by liquimeters and seal wear counters. Enter these values (or values slightly less than the displayed values) as EMF limits, and then reset the EMF counters to zero. The next time the EMF counters exceed the new EMF limits, the EMF flag will be displayed, providing a reminder that maintenance needs to be scheduled.

# The Electronics

The electronics are comprised of four main components:

- **The nano pump main board** (NPM), see page 207.
- **The power supply**, see page 228.

Optional:

- **The interface board** (BCD/external contacts), see page 215.
- **The interface board** (LAN), see page 217.

## Nano pump main board (NPM)

The board controls all information and activities of all assemblies within the nano pump. The operator enters parameters, changes modes and controls the nano pump through interfaces (CAN, GPIB or RS-232C), connected to the user-interfaces. Figure 41 and Figure 42 show block diagrams of this board.

### ASIC — Application-Specific Integrated Circuit

The application-specific integrated circuit (ASIC) includes all digital logic for the core processor functions and also for module-specific functions.

### Motor Drive

There are two identical motor drives for the drive assemblies. Each drive comprises motor control, motor amplifier (drive) and current control.

### Active Inlet Valve Drive

There are two identical valve drives for the two active inlet valves. Each drive comprises two amplifiers for the two contacts of valve solenoid.

### Solvent Selection Valve Drive

This drive consists of amplifiers for the solenoids of the solvent selection valve.

### Electromagnetical Proportional Valve.

The EMPV consists of an electro-magnetic solenoid, driven by a PWM (Pulse Width Modulator).

### Pressure Converter

This block comprises a filter and amplifier for the pressure-sensor-signal, a multiplexer, an A/D converter and an offset correction for the analog pressure output signal. The output voltage is 2 mV/bar.

### Leak Converter

This block comprises a PTC for the leak identification and a NTC for the ambient temperature measurement. This assures that temperature changes are not identified as leak. A leak would cool down the PTC and its change in resistance results in a leak signal.

### Fan Drive

The revolution of the fan is controlled by the main processor depending on the internal heat distribution in the nano pump. The fan provides a PWM signal which is proportional to the revolution. This fan status signal is used for diagnostics.

### Electronic Fuses

The valve circuits are electronically fused on the board. Any error on the board or shortages of the valves will activate the electronic fuses that will switch off the supply voltage. This prevents the damage of components.

### Onboard Battery

An onboard lithium battery buffers the electronic memories when the nano pump is turned off.

For safety information on lithium batteries, see “Lithium Batteries Information” on page 265.

### Interfaces

The nano pump provides the following interfaces:

- two CAN connectors as interface to other Agilent 1100 Series modules,

- one GPIB connector as interface to the Agilent ChemStation,
- one RS-232C as interface to a computer,
- one REMOTE connector as interface to other Agilent products,
- one analog output for pressure signal output, and
- one optional interface board.
- LAN.

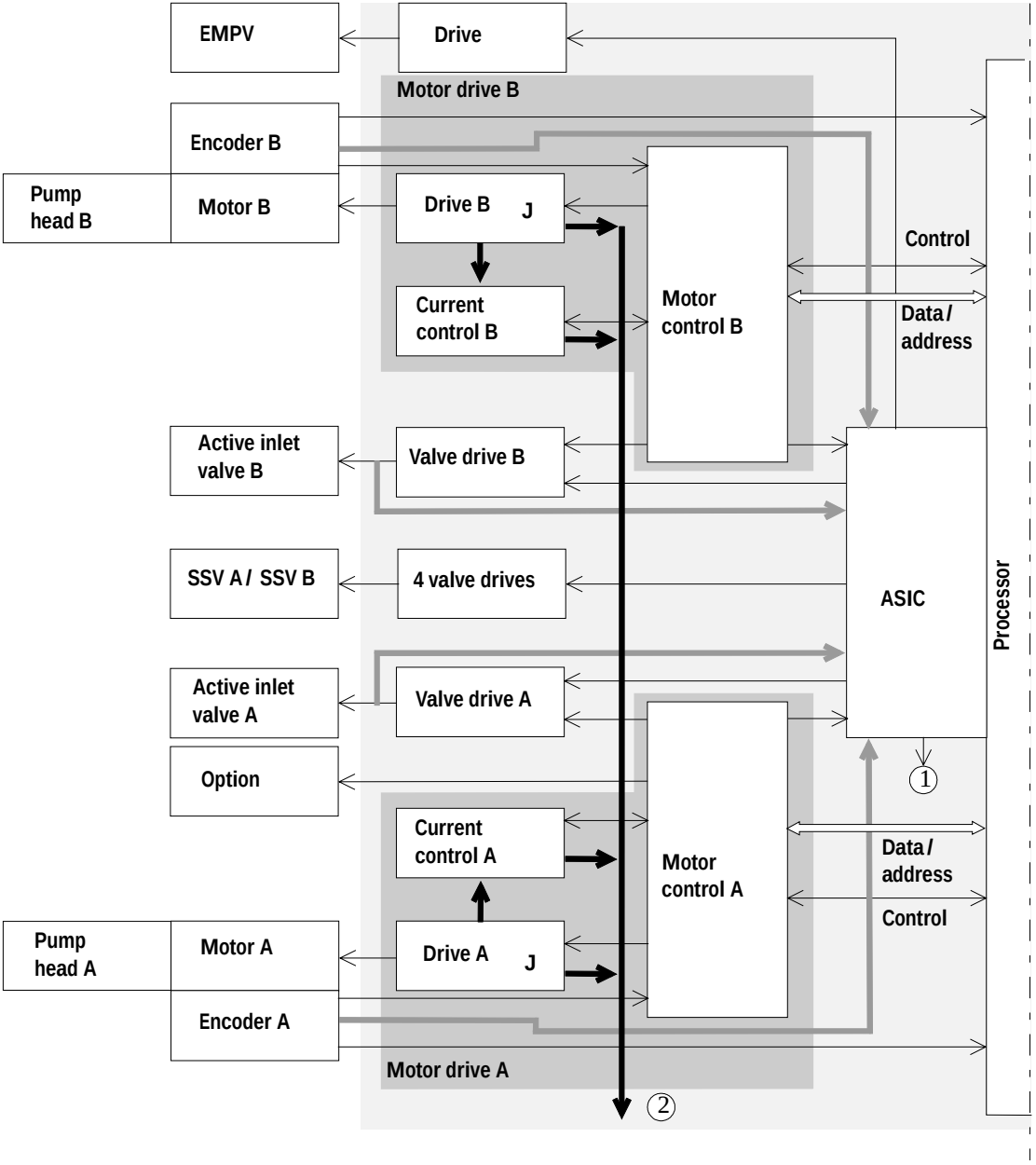



**Figure 41** Block Diagram Pump Controller Board

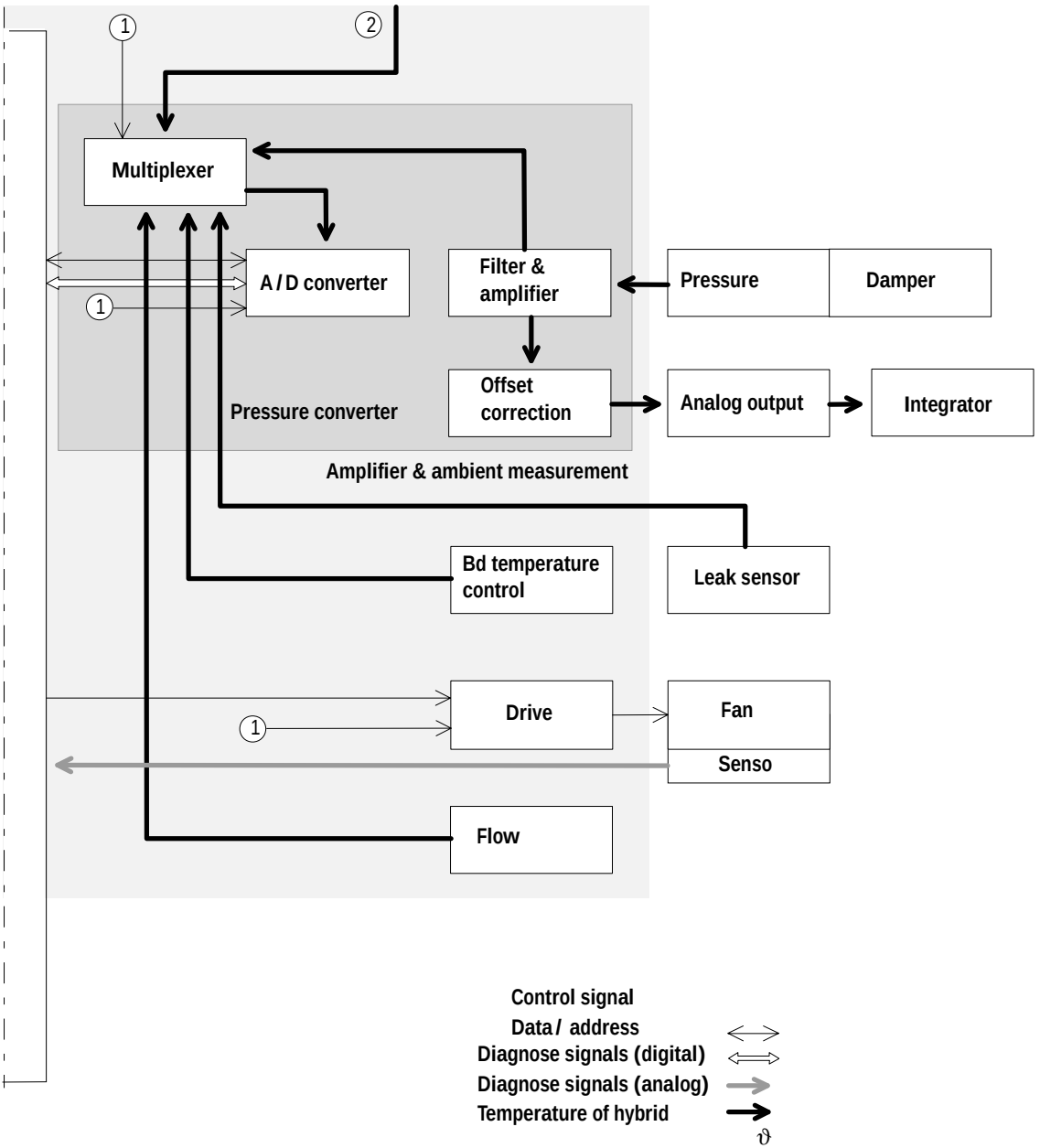



**Figure 42** Block Diagram Pump Controller Board

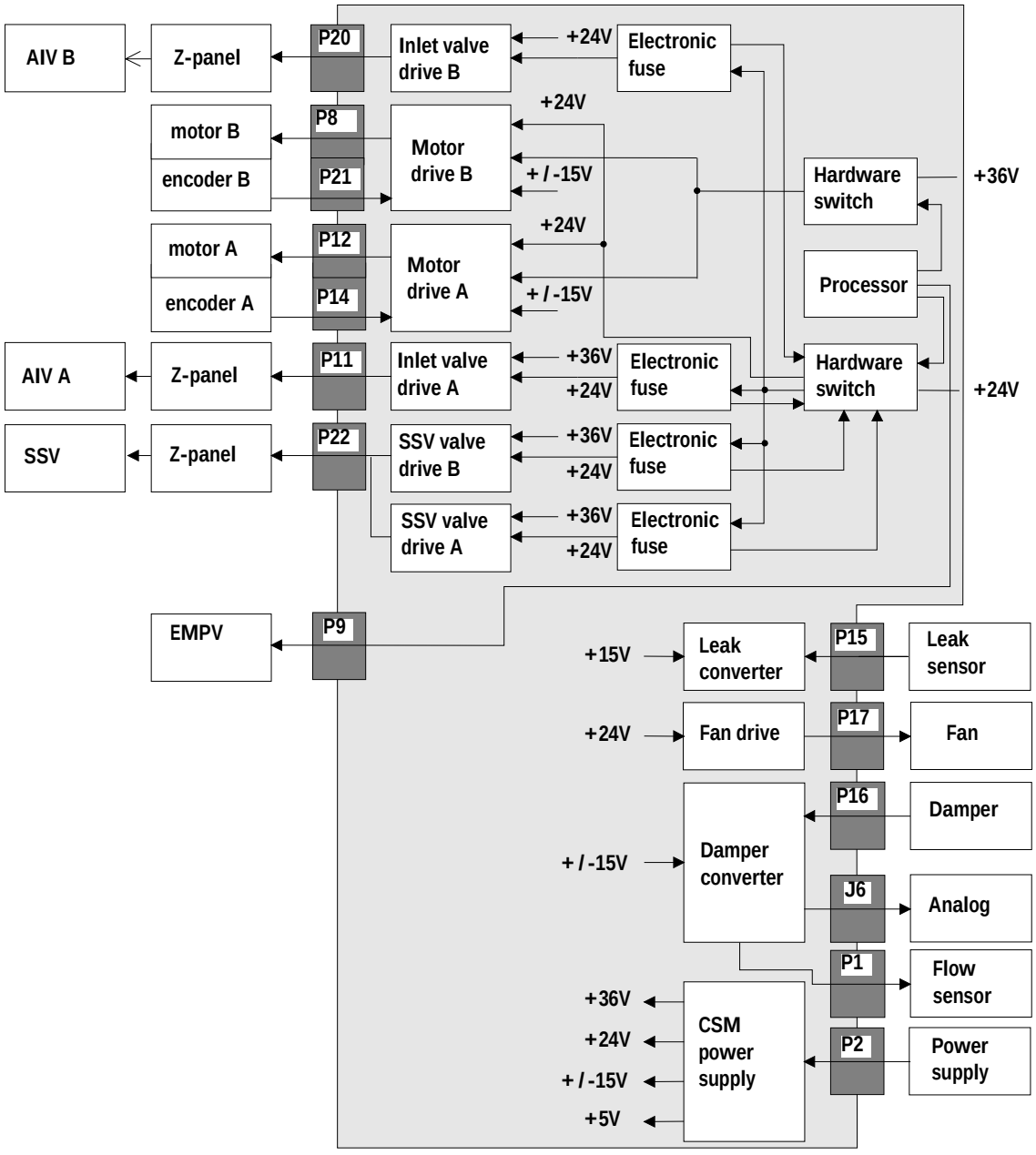



**Figure 43** Interconnection Diagram NPM Board

# Firmware Description

The firmware of the instrument consists of two independent sections:

- a non-instrument specific section, called ‘resident system’,
- an instrument specific section, called ‘main system’.

## Resident System

This resident section of the firmware is identical for all Agilent 1100 series modules. Its properties are:

- the complete communication capabilities (GPIB, CAN, LAN and RS-232C),
- memory management,
- ability to update the firmware of the ‘main system’.

## Main System

Its properties are:

- the complete communication capabilities (GPIB, CAN, LAN and RS-232C),
- memory management,
- ability to update the firmware of the ‘resident system’.

In addition the main system comprises the instrument functions that are divided into common functions like

- run synchronization via APG remote
- error handling,
- diagnostic functions and so on,

or module specific functions like

- internal events such as motor control, flow rates and so on,
- calculation of compensation values for variable strokes and pressures.

## Firmware Updates

Firmware updates can be done using your user interface:

- handheld control module with files from a PC-card or
- Agilent ChemStation with files from floppy disk

The file naming conventions are:

xxxx-vvv.DLB, where

xxxx is the product number, e.g. 2226 for the G2226A Nano Pump), and vvv is the revision number, for example 503 is revision 5.03.

For instructions refer to your user interface.

NOTE Update of main system can be done in the resident system only.

Update of the resident system can be done in the main system only.

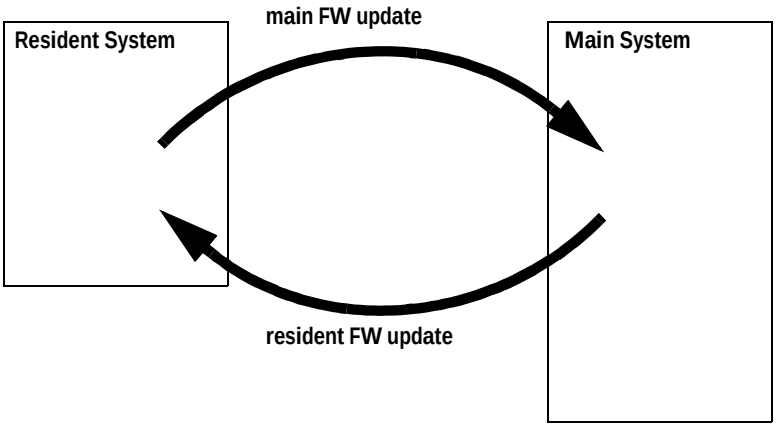



**Figure 44** Firmware Update Mechanism

# Optional Interface Boards

The Agilent 1100 Series modules have one optional board slot that allows addition of an interface board to the modules.

**Table 48** Optional Interface Boards

| Description | Part Number |
|---|---|
| BCD Board | G1351-68701 |
| Fuse 250 mA (four are on the board) | 2110-0004 |
| LAN Board (see next page for details) | |

## BCD Board

The BCD board provides a BCD output for the bottle number of the Agilent 1100 Series well-plate sampler and four external contacts. The external contact closure contacts are relay contacts. The maximum settings are: 30 V (AC/DC); 250 mA (fused). There is a general purpose cable available to connect the BCD output, see “BCD Cables” on page 184 and the external outputs, see “External Contact Cable” on page 189 to external devices.

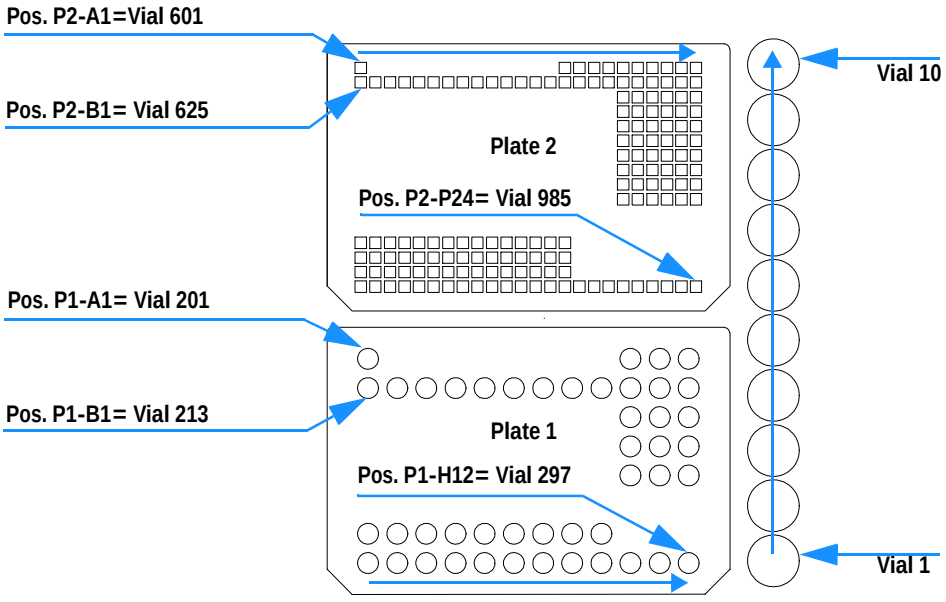



**Figure 45** BCD output for the well plates

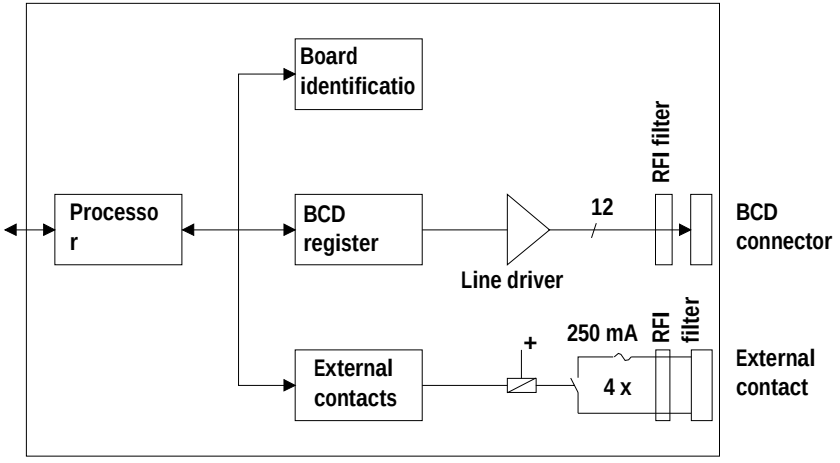



**Figure 46** Block Diagram BCD Board

## LAN Board

The HP JetDirect cards are network interface cards used in HP printers.

NOTE One board is required per Agilent 1100 stack. It is recommended to add the LAN board to the detector with highest data rate.

NOTE The LAN board can only be used together with:

a main board version G13XX-66520 (DAD/MWD/VWD/Pump/ALS) or G13XX-66500 (FLD/RID) and above.

an Agilent-ChemStation software revision A.06.01 or above.

The following cards can be used with the Agilent 1100 modules.

**Table 49** LAN Boards

| Agilent Order Number | Supported networks |
|---|---|
| J4106A | Ethernet/802.3, RJ-45 (10Base-T( |
| J4105A | Token Ring/802.5, DB9, RJ-45 (10Base-T) |
| J4100A | Fast Ethernet, Ethernet/802.3, RJ-45 (10/100Base-TX) + BNC (10Base2) |

NOTE Minimum firmware of the JetDirect cards is A.05.05.

### Recommended Cables

For point to point connection (not using a network hub) use a twisted pair cross over LAN cable (P/N 5183-4649, 10 feet long).

For standard network connections using a hub use category 5 UTP cables, (P/N G1530-61480, 8 m long).

# Interfaces

The Agilent 1100 Series modules provide the following interfaces:

**Table 50** Agilent 1100 Series Interfaces

| Interface Type | Pumps | Autosampler | Well-plate Sampler | DA Detector MW Detector FL Detector | VW Detector RI Detector | Thermostatted Column Compartment | Vacuum Degasser |
|---|---|---|---|---|---|---|---|
| CAN | Yes | Yes | Yes | Yes | Yes | Yes | No |
| GPIB | Yes | Yes | No* | Yes | Yes | Yes | No |
| RS-232C | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Remote | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Analog | Yes | No | No | 2 × | 1 × | No | Yes† |
| Interface board | Yes | Yes | Yes | Yes | Yes | No | No |

* The well-plate sampler can be controlled through CAN via a detector that is connected via GPIB to a ChemStation.

† The vacuum degasser will have a special connector for specific use. For details see description of main board.

- CAN connectors as interface to other Agilent 1100 Series modules,
- GPIB connector as interface to the Agilent ChemStation,
- RS-232C as interface to a computer,
- REMOTE connector as interface to other Agilent products,
- Analog Output connector(s) for signal output, and
- Interface slot for specific interfacing (external contacts, BCD, LAN and so on).

For identification and location of the connectors Figure 5 on page 13.

**WARNING** **Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.**

## Analog Signal Output

The analog signal output can be distributed to a recording device. For details refer to the description of the module's main board.

## GPIB Interface

NOTE A chemstation cannot be connected directly to the well-plate sampler by GPIB.

The GPIB connector is used to connect the module with a computer. The address and control switches next to the GPIB connector determine the GPIB address of your module. The switches are preset to a default address and recognized by the operating software from Agilent Technologies.

**Table 51** Default Addresses

| | | | |
|---|---|---|---|
| Autosampler | 28 | RID | 29 |
| Pump | 22 | | |
| FLD | 23 | | |
| VWD | 24 | Autosampler (HP 1050) | 18 |
| Agilent 8453A | 25 | Pump (HP 1050) | 16 |
| DAD / MWD | 26 | VWD (HP 1050) | 10 |
| Column Compartment | 27 | DAD (HP 1050) | 17 |

## CAN Interface

The CAN is an intermodule communication interface. It is a 2-wire serial bus system supporting high speed data communication and real-time requirement.

## Remote Interface

The APG remote connector may be used in combination with other analytical instruments from Agilent Technologies if you want to use features such as common shut down, prepare, and so on.

Remote control allows easy connection between single instruments or systems to ensure coordinated analysis with simple coupling requirements.

The subminiature D connector is used. The module provides one remote connector which is inputs/outputs (wired-or technique).

To provide maximum safety within a distributed analysis system, one line is dedicated to SHUT DOWN the system's critical parts in case any module detects a serious problem. To detect whether all participating modules are switched on or properly powered, one line is defined to summarize the POWER ON state of all connected modules. Control of analysis is maintained by signal readiness READY for next analysis, followed by START of run and optional STOP of run triggered on the respective lines. In addition, PREPARE and START REQUEST may be issued. The signal level is defined as:

- standard TTL levels (0 V is logic true, + 5 V is false),
- fan-out is 10,
- input load is 2.2 kOhm against + 5 V, and
- outputs are open collector type, inputs/outputs (wired-or technique).

**Table 52** Remote Signal Distribution

| Pin | Signal | Description |
|---|---|---|
| 1 | DGND | Digital ground |
| 2 | PREPARE | (L) Request to prepare for analysis (for example, calibration, detector lamp on). Receiver is any module performing pre-analysis activities. |
| 3 | START | (L) Request to start run / timetable. Receiver is any module performing run-time controlled activities. |
| 4 | SHUT DOWN | (L) System has serious problem (for example, leak: stops pump). Receiver is any module capable to reduce safety risk. |
| 5 | | Not used |

**Table 52** Remote Signal Distribution, continued

| Pin | Signal | Description |
|---|---|---|
| 6 | POWER ON | (H) All modules connected to system are switched on. Receiver is any module relying on operation of others. |
| 7 | READY | (H) System is ready for next analysis. Receiver is any sequence controller. |
| 8 | STOP | (L) Request to reach system ready state as soon as possible (for example, stop run, abort or finish and stop injection). Receiver is any module performing run-time controlled activities. |
| 9 | START REQUEST | (L) Request to start injection cycle (for example, by start key on any module). Receiver is the autosampler. |

## RS-232C

The RS-232C connector is used to control the instrument from a computer through RS-232C connection, using the appropriate software. This connector can be activated by the configuration switch module next to the GPIB connector.

The RS-232C is designed as DCE (Data Communication Equipment) with a 9-pin male SUB-D type connector. The pins are defined as follows:

**Table 53** RS-232C Connection Table

| Pin | Direction | Function |
|---|---|---|
| 1 | In | DCD |
| 2 | In | RxD |
| 3 | Out | TxD |
| 4 | Out | DTR |
| 5 | | Ground |
| 6 | In | DSR |
| 7 | Out | RTS |
| 8 | In | CTS |

**Table 53** RS-232C Connection Table, continued

| Pin | Direction | Function |
|---|---|---|
| 9 | In | RI |

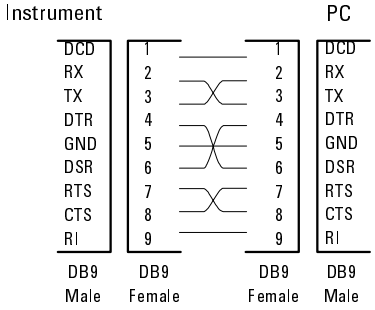



**Figure 47** RS-232 Cable

# Setting the 8-bit Configuration Switch

The 8-bit configuration switch is located next to the GPIB connector. Switch settings provide configuration parameters for GPIB address, serial communication protocol and instrument specific initialization procedures.

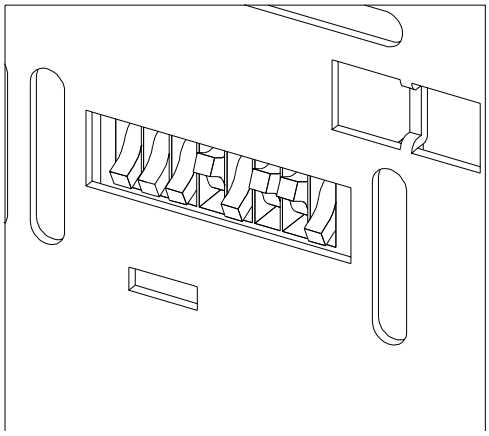


**Figure 48** 8-bit Configuration Switch

**Table 54** 8-bit Configuration Switch

| Mode Select | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| GPIB | 0 | 0 | | GPIB Address | | | | |
| RS-232C | 0 | 1 | Baudrate | | | Data Bits | Parity | |
| Reserved | 1 | 0 | Reserved | | | | | |
| TEST/BOOT | 1 | 1 | RSVD | SYS | | RSVD | RSVD | FC |

Switches 1 and 2 define which set of parameters (for example, for GPIB, RS-232C, and so on) will be changed. Once the change has been completed, the instrument must be powered up again in order to store the values in the non-volatile memory.

In the non-volatile memory the parameters are kept, regardless of whether you turn the instrument off and on again. They will be kept until the same set of parameters is subsequently changed and power is reset. All other previously stored configuration settings will still remain in the non-volatile memory.

In this way you can store more than one set of parameters using the same 8-bit configuration switch twice, for example, for both GPIB and RS-232C.

## GPIB Default Addresses

If you just want to change the GPIB address and need a detailed procedure, refer to the *Installing Your Agilent ChemStation System* handbook.

Default GPIB address is set to the following addresses:

**Table 55** Default Addresses for Agilent Series 1100 Modules

| Module | Address | Binary Address |
|---|---|---|
| Pump | 22 | 0 0 0 1 0 1 1 0 |
| FLD | 23 | 0 0 0 1 0 1 1 1 |
| VWD | 24 | 0 0 0 1 1 0 0 0 |
| Agilent 8453A | 25 | 0 0 0 1 1 1 0 1 |
| DAD / MWD | 26 | 0 0 0 1 1 0 1 0 |
| Column compartment | 27 | 0 0 0 1 1 0 1 1 |
| Autosampler | 28 | 0 0 0 1 1 1 0 0 |
| Well-plate sampler | no address | 000000000000 |
| RID | 29 | 0 0 0 1 1 1 0 1 |

where 0 means that the switch is down and 1 means that the switch is up.

## Communication Settings for RS-232C Communication

The communication protocol used in this instrument supports only hardware handshake (CTS/RTS).

Switches 1 in down and 2 in up position define that the RS-232C parameters will be changed. Once the change has been completed, the instrument must be powered up again in order to store the values in the non-volatile memory.

**Table 56** Communication Settings for RS-232C Communication

| Mode Select | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| RS-232C | 0 | 1 | Baud rate | | | Data Bits | Parity | |

Use the following tables for selecting the setting which you want to use for RS-232C communication. The number 0 means that the switch is down and 1 means that the switch is up.

**Table 57** Baud Rate Settings

| Switches | | | Baud Rate | Switches | | | Baud Rate |
|---|---|---|---|---|---|---|---|
| 3 | 4 | 5 | | 3 | 4 | 5 | |
| 0 | 0 | 0 | 9600 | 1 | 0 | 0 | 9600 |
| 0 | 0 | 1 | 1200 | 1 | 0 | 1 | 14400 |
| 0 | 1 | 0 | 2400 | 1 | 1 | 0 | 19200 |
| 0 | 1 | 1 | 4800 | 1 | 1 | 1 | 38400 |

**Table 58** Data Bit Settings

| Switch 6 | Data Word Size |
|---|---|
| 0 | 7 Bit Communication |
| 1 | 8 Bit Communication |

**Table 59** Parity Settings

| Switches | | Parity |
|---|---|---|
| 7 | 8 | |
| 0 | 0 | No Parity |

**Table 59** Parity Settings, continued

| | | |
|---|---|---|
| 1 | 0 | Odd Parity |
| 1 | 1 | Even Parity |

One start bit and one stop bit are always used (not selectable).

Per default, the module will turn into 19200 baud, 8 data bit with no parity.

## Forced Cold Start Settings

Switches 1 and 2 do not force storage of this set of parameters in non-volatile memory. Returning switches 1 and 2 to other positions (other than being both up) will allow for normal operation.

**CAUTION** Forced cold start erases all methods and data stored in the non-volatile memory. Exceptions are diagnose and repair log books which will not be erased.

If you use the following switch settings and power the instrument up again, a forced cold start has been completed.

**Table 60** Forced Cold Start Settings

| Mode Select | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| TEST/BOOT | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

To return to normal operation, set switches back to your GPIB or RS 232 configuration settings.

## Stay-Resident Settings

Firmware update procedures may require this mode in case of firmware loading errors.

Switches 1 and 2 do not force storage of this set of parameters in non-volatile memory. Returning switches 1 and 2 to other positions (other than being both up) will allow for normal operation.

If you use the following switch settings and power the instrument up again, the instrument firmware stays in the resident part, that is, it is not operable as a detector. It only uses basic functions of the operating system for example, for communication.

**Table 61** Stay Resident Settings

| Mode Select | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| TEST/BOOT | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |

To return to normal operation, set switches back to your GPIB or RS-232C configuration settings.

# The Main Power Supply Assembly

The main power supply comprises a closed assembly (no onsite repair possibility).

The power supply provides all DC voltages used in the module except for the voltages supplied by the lamp power supply to the deuterium and tungsten lamps in the detectors. The line voltage can vary in a range from 100  240 volts AC ± 10 % and needs no manual setting.

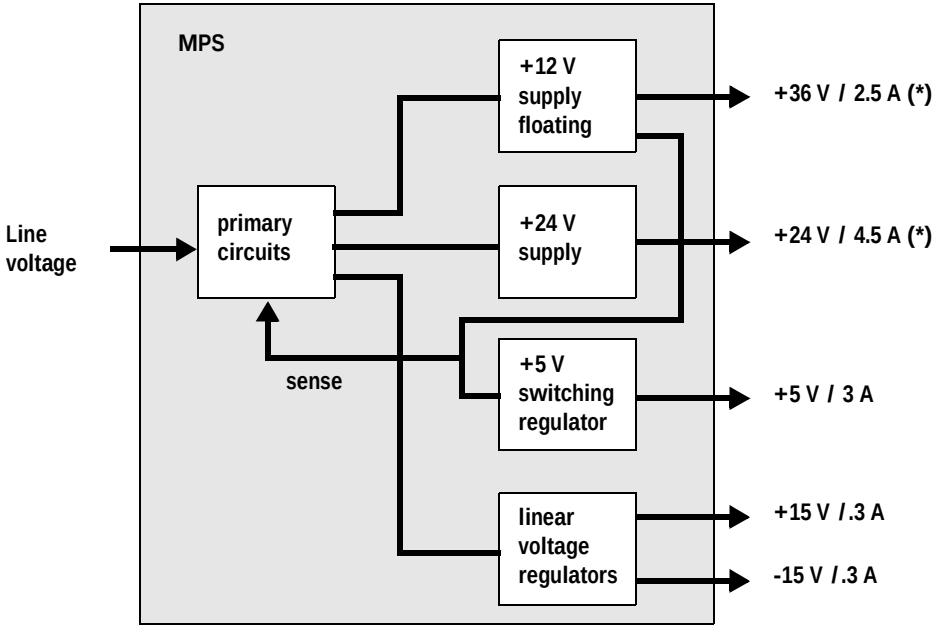

MPS
+12 V supply floating
+36 V / 2.5 A (*)
Line voltage
primary circuits
+24 V supply
+24 V / 4.5 A (*)
sense
+5 V switching regulator
+5 V / 3 A
linear voltage regulators
+15 V /.3 A
-15 V /.3 A
(*) total power consumption on +36 V and +24 V must not exceed 107 watts.

**Figure 49** Main Power Supply (MPS) Block diagram

To disconnect the instrument from line, unplug the power cord. The power supply still uses some power, even if the power switch on the front panel is turned off.

No accessible hardware fuse is needed because the main power supply is safe against any short circuits or overload conditions on the output lines. When overload conditions occur, the power supply turns off all output voltages. Turning the line power off and on again resets the power supply to normal operation if the cause of the overload condition has been removed.

An over-temperature sensor in the main power supply is used to turn off output voltages if the temperature exceeds the acceptable limit (for example, if the cooling fan of the instrument fails). To reset the main power supply to normal operating conditions, turn the instrument off, wait until it is approximately at ambient temperature and turn the instrument on again.

The following table gives the specifications of the main power supply.

**Table 62** Main Power Supply Specifications

| | | |
|---|---|---|
| Maximum power | 300 VA / 200 W | Continuous output |
| Line Input | 100 – 240 volts AC<br>± 10 %, line frequency of 50/60 Hz | Wide ranging |
| Output 1 | + 24 V / 4.5 A (maximum) | total power consumption of + 24 V and + 36 V must not exceed 107 W. |
| Output 2 | + 36 V / 2.5 A (maximum) | |
| Output 3 | + 5 V / 3 A | |
| Output 4 | + 15 V / 0.3 A | |
| Output 5 | - 15 V / 0.3 A | |

# 6 Control Module Screens for the Nano Pump

Major keys on the Agilent 1100 Control Module 232
Screens available from the Analysis view 233
Screens available from the System view 245
Screens available from the Records screen 248
Diagnostics and Tests 254

# Major keys on the Agilent 1100 Control Module

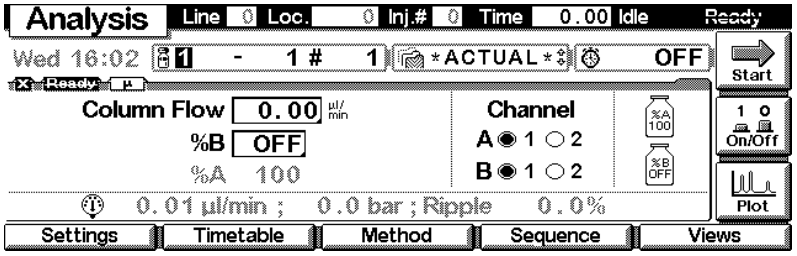
| | |
|---|---|
| **ESC** | Return to previous screen, abort any change of parameters and toggle between the last two top layer views |
| **m** | Open context sensitive menus |
| **i** | Information / Help |
| **Enter** | Store changed parameters or execute a choice |
| **Done** | (If available) Activate settings of current screen |
| **On / Off** | Switch on individual Instrument(s) or complete System |
| **Start** | Start a location range or sequence |
| **Plot** | View online signals |
| **Views** | Change between analysis - (samples)- status - system views |

NOTE The screens shown on the next pages are based on the following firmware revisions:
Control Module firmware revision B.02.0x (G1323B).
HPLC Module firmware revision 5.0x.

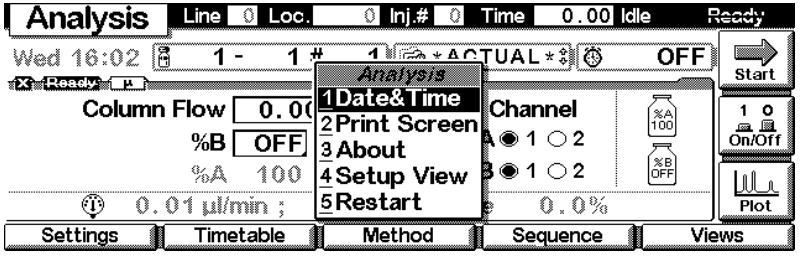
NOTE In case the control module's display seems to be frozen (hang-up due to a communication problem on the CAN bus) unplug the control module from the HPLC module and reconnect.

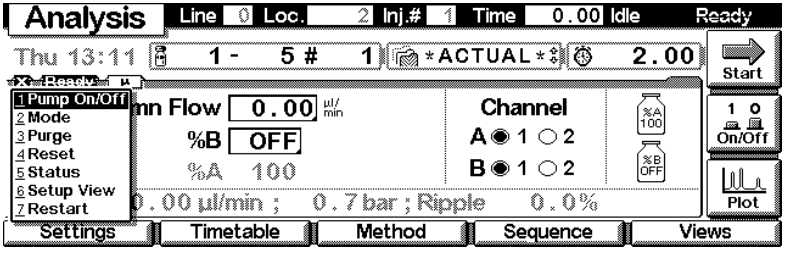
# Screens available from the Analysis view

**Analysis view** This is the wake-up screen, if the Agilent 1100 capillary pump is the only configured Agilent 1100 module. It is used to enter the most common pump method parameters.



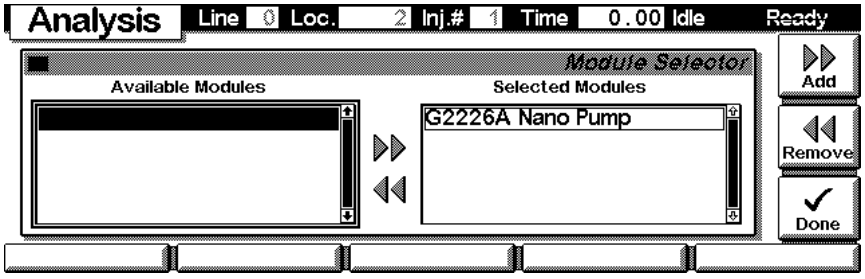

The **m**-key allows access to the context sensitive menus. **Date&Time** allows you to change time settings. **Print Screen** gives access to the print screen. **About** tells you the current firmware revision and the serial# of your control module. **Setup view** leads you to analysis view configuration for additional Agilent 1100 modules. **Restart** re-boots the control module.



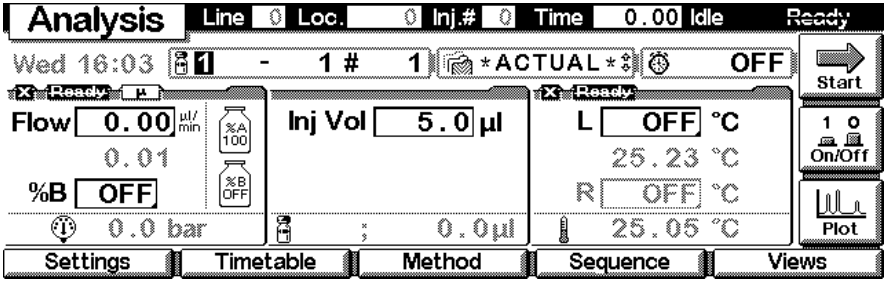



**Setup View**

In the Setup view, modules can be added or removed to the analysis view. Select a module, you want to move, with the help of the **selection** keys. Use function keys **F7/F8** (**Remove/Add**) to move the highlighted module. Changes must be activated with **Done** (**F6**).

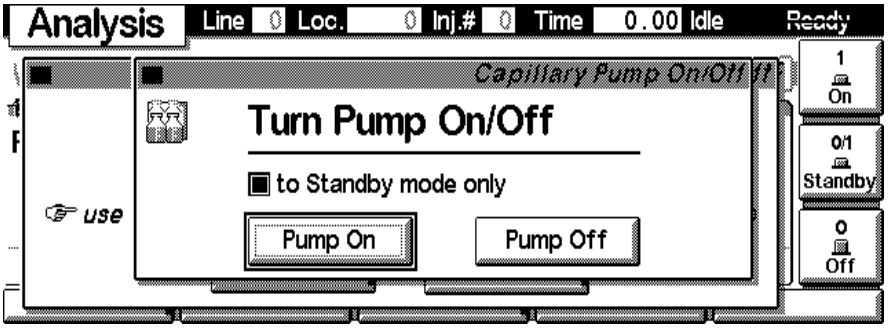


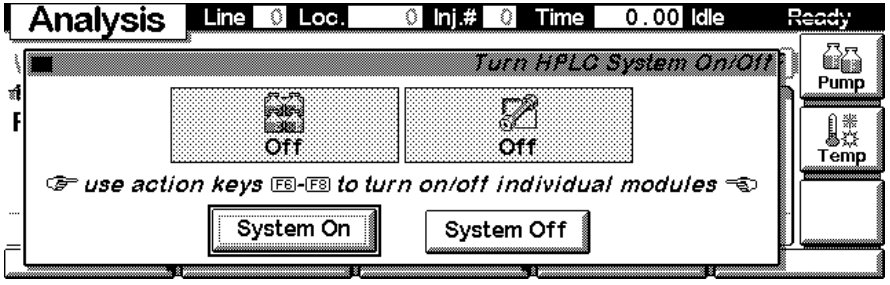

Here, e.g. the autosampler and the thermostatted column compartment parameters are shown on the display as well. The number of parameters for each module is reduced as additional modules are added to the display. A maximum of 4 modules can be shown simultaneously (If more modules are connected to the system, you can choose up to 4 of them in Setup view).



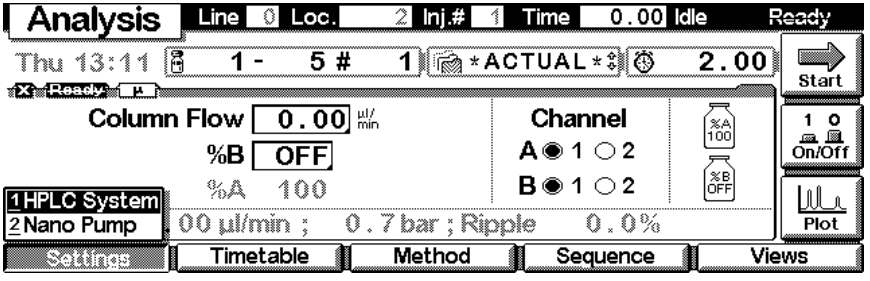

**On / Off**

From the Analysis screen use the **F7**-key (**On / Off**) to proceed to the turn on screen. Press **F8** (**On**) once to turn on the pump. If more than one module is available, select **F8** (**Pump**) or turn on the entire system by selecting the **System On** button and pressing **Enter**.



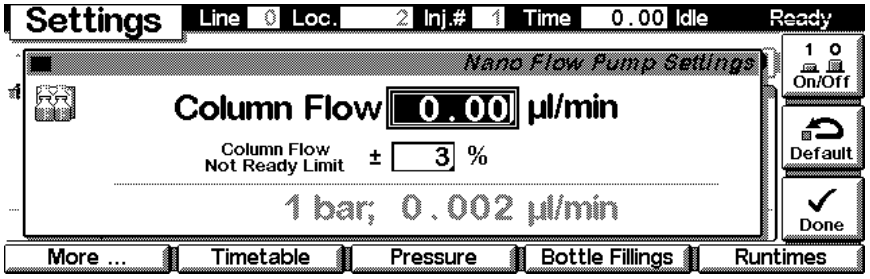




**Settings** With the **F1**-key (**Settings**) you open a pull-down menu where you can select the capillary pump module with the help of the **selection** or **alphanumeric** keys.

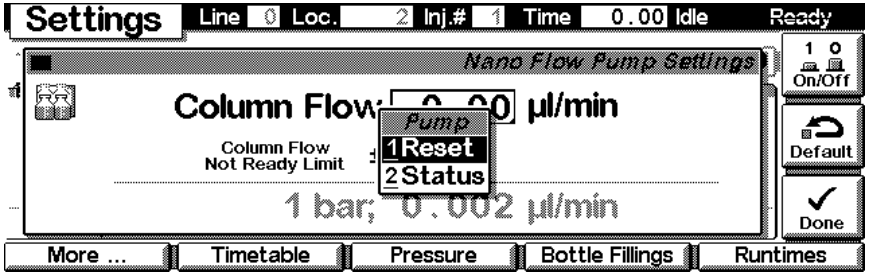


## Settings screens

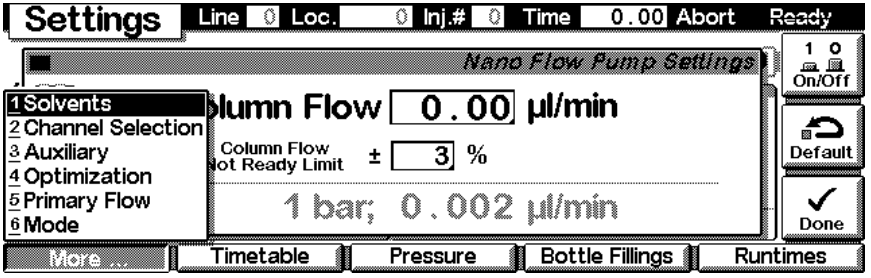
**Settings** In the **Settings** screen you can change the pump parameters. Here, you can enter values for the column flow/not ready limit. In addition, you have access to a different set of parameters available through the **F1-5 navigation**-keys. The **F7**-key (**Default**) resets the pump to default values. **F8** (**On/Off**) opens a window to turn on the pump.Changes must be acknowledged with **F6** (**Done**).

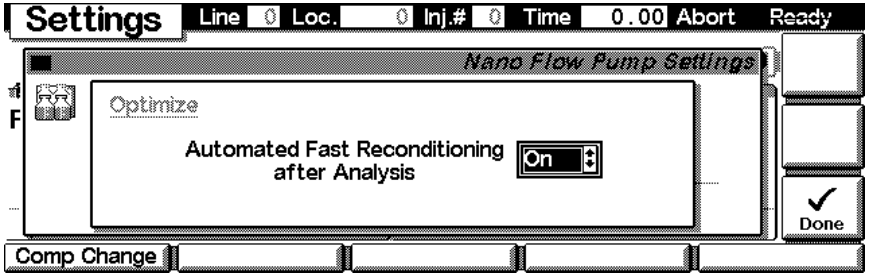


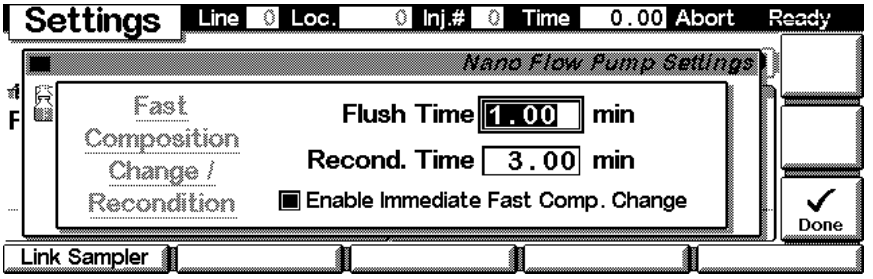

Use the **m**-key for the context sensitive menu. **Reset** will load the pump default parameters. The **Status** command pulls up the module specific setup screen.




Use the **F1**-key (**More**) to enter special pump setpoints:

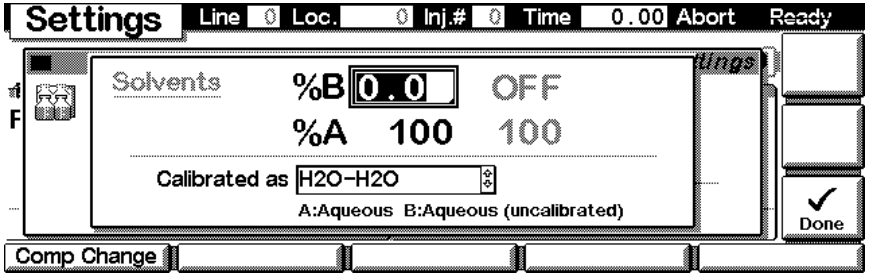




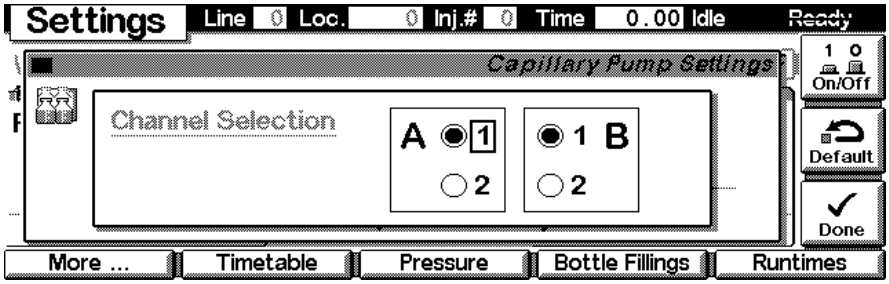


Settings
Line 0 Loc. 0 Inj.# 0 Time 0.00 Abort Ready
Nano Flow Pump Settings
Fast Composition Change / Recondition
Flush Time 1.00 min
Recond. Time 3.00 min
Enable Immediate Fast Comp. Change
Done
Link Sampler

**Settings - More...**

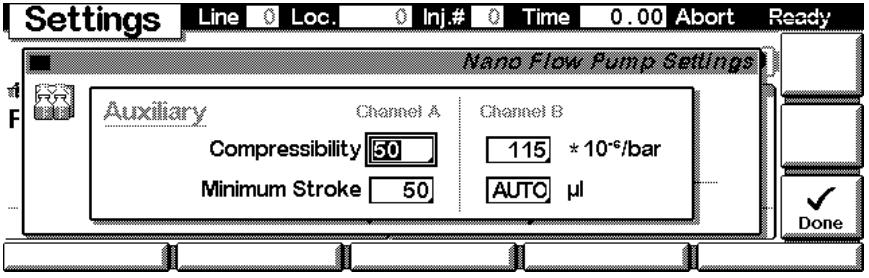
Select **Solvents** to choose an appropriate calibration curve for binary solvent mixtures. Please note, that the left mobile phase in the line must be pumped from channel A, the right one must be connected to channel B. Changes must be activated with **F6** (**Done**).




Select **Channel Selection** to choose one of the A-channels (1 or 2) and one of the B-channels (1 or 2) as the sources for solvent delivery. Changes must be activated with **F6** (**Done**).

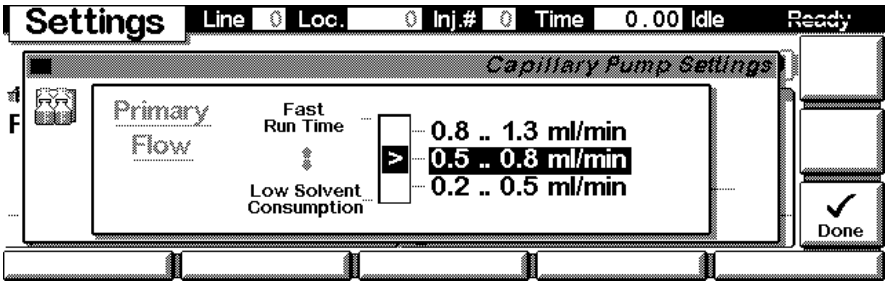



**Settings More...** Select **Auxiliary** to access the pumps performance optimization parameters (Compressibility and Minimum Strike) for each channel individually. Changes must be activated with **F6** (**Done**).

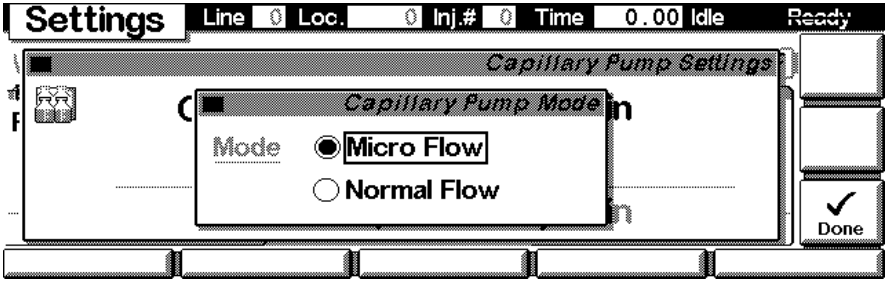


NOTE The following screen is only available in **'Micro Flow' mode** (see below).

Select **Primary Flow** to choose one of the three possible ranges for the primary flow. Changes must be activated with **F6** (**Done**).

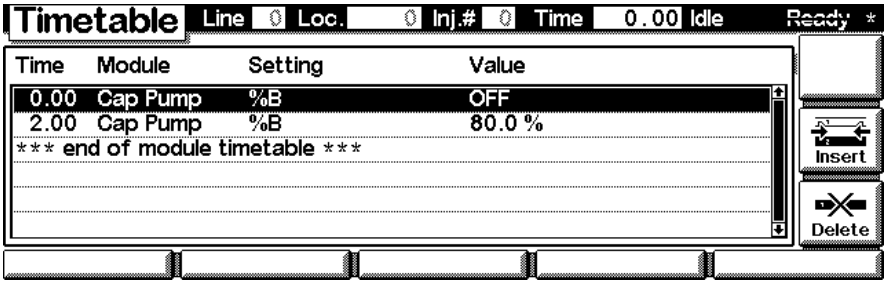



Select **Mode** to toggle between '**Micro Flow**' and '**Normal Flow'**. Changes must be activated with **F6** (**Done**).

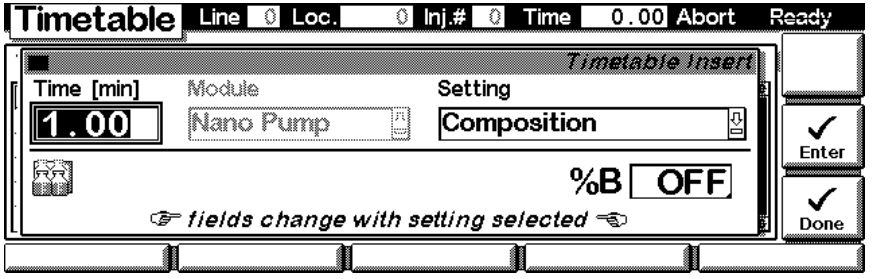



**Settings - Timetable**

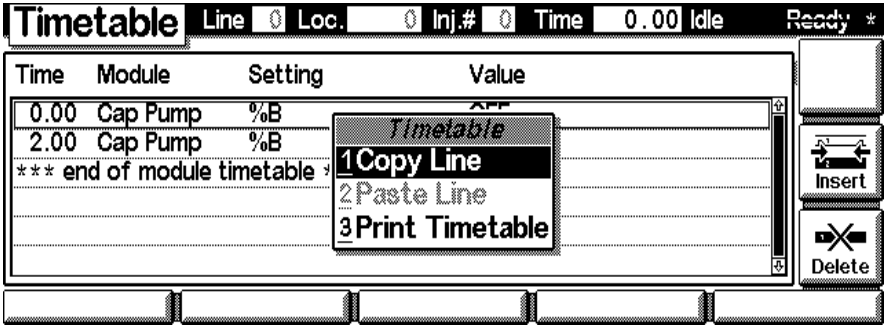
With the **F2**-key (**Timetable**) you can list and edit the timetable for the pump. Press **F7**-key (**Insert**) to add entries, **F6**-key (**Delete**) to remove or **Enter** to edit selected/highlighted entries.


Timetable
Line 0 Loc. 0 Inj.# 0 Time 0.00 Idle Ready *
Time Module Setting Value
0.00 Cap Pump %B OFF
2.00 Cap Pump %B 80.0 %
*** end of module timetable ***
Insert
Delete

Edit the different sections of each timetable line. Use the pull-down menus, if available. Use the **F6**-key (**Done**) to view the entered lines of the timetable or **F7** (**Enter**) to acknowledge current settings.

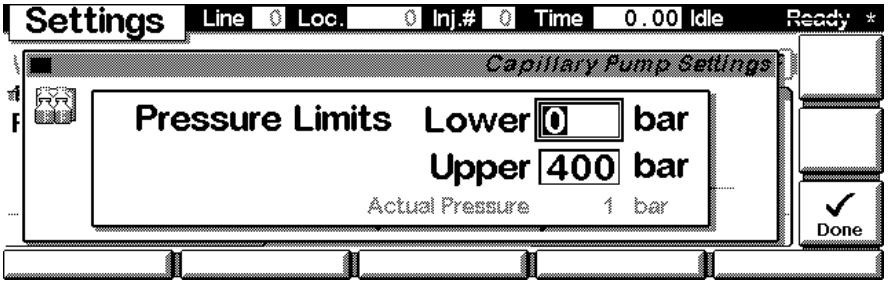



Use the **m**-key for the context sensitive menu. It gives you additional tools for the timetable.



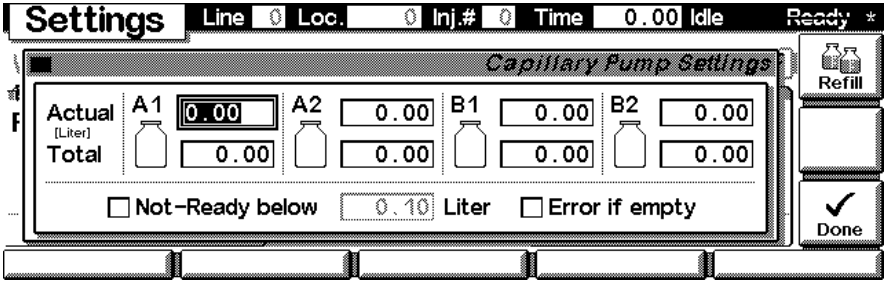

## Settings - Pressure

With the **F3**-key (**Pressure**) you can change the settings for the pressure limits.


Settings
Line 0 Loc. 0 Inj.# 0 Time 0.00 Idle Ready *
Capillary Pump Settings
Pressure Limits Lower 0 bar
Upper 400 bar
Actual Pressure 1 bar
Done

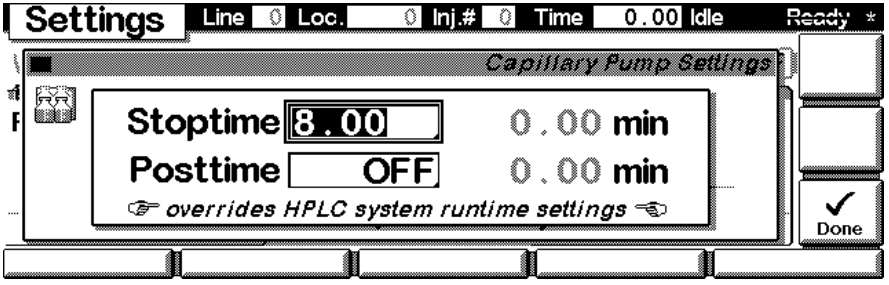
**Settings - Bottle Fillings**

With the **F4**-key (**Bottle Fillings**) you can adjust the settings for the bottle fillings to their current state. Select **F8** (**Refill**) to refill **All** bottles or a **Selected** bottle to total volume. By selecting the respective tick-boxes, you can also choose whether and when to have **Not-Ready** or **Error** conditions. Changes must be activated with **F6** (**Done**).



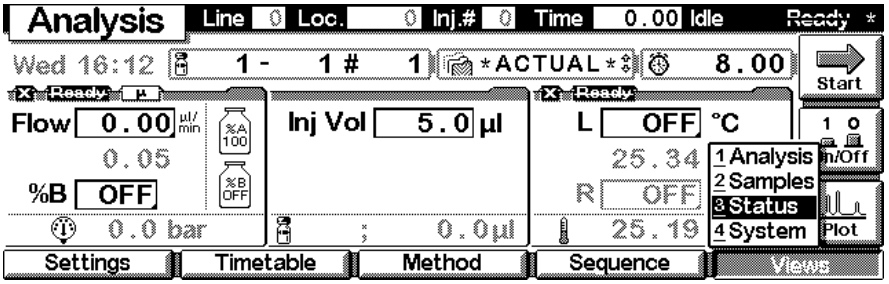

**Settings - Runtimes**

With the **F5**-key (**Runtimes**) you can change the stop time and the post-run time for this module individually. Changes must be activated with **F6** (**Done**).

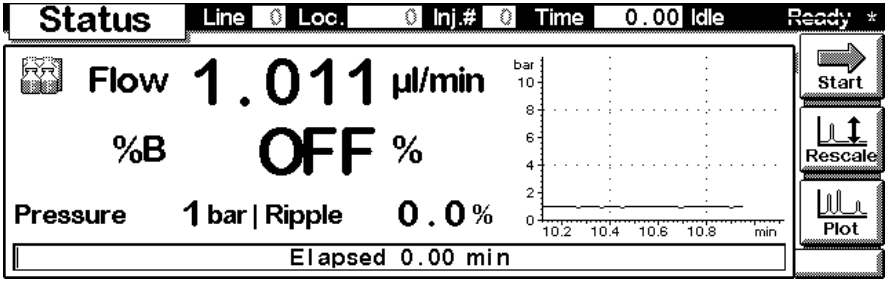

Settings
Line 0 Loc. 0 Inj.# 0 Time 0.00 Idle Ready *
Capillary Pump Settings
Stoptime 8.00 0.00 min
Posttime OFF 0.00 min
overrides HPLC system runtime settings
Done

**Analysis -Status**

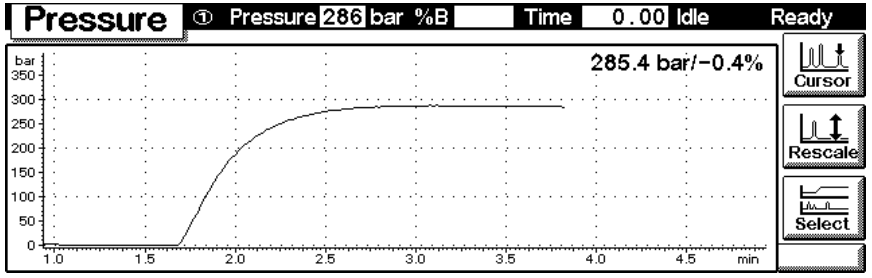
Press **F5**-key (**Views**) and select **Status**.



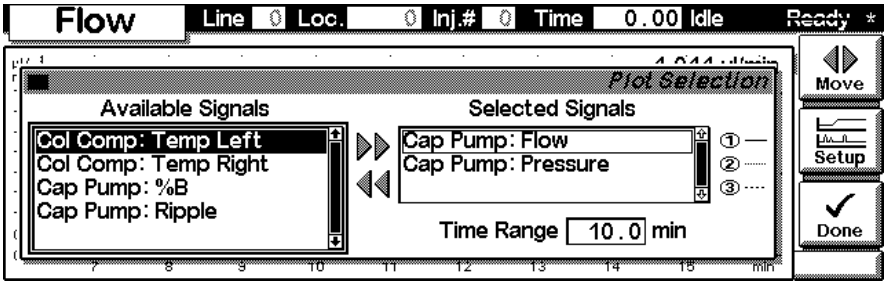

**Status** This is an example if an Agilent 1100 pump is configured standalone. Information on the actual flow rate, mobile phase composition, pressure and %-Ripple, elapsed run time and the pressure plot are shown. Press key **F8** (**Start**) to start a run, key **F7** (**Rescale**) to maximize the signal.




**Signal plot** Press **F6**-key (**Plot**) to enter the plot screen (available also from all other **views**). Here you can observe online signal(s). If more than one signal is configured, use the 1-2-3 numeric keys to switch between the signals.



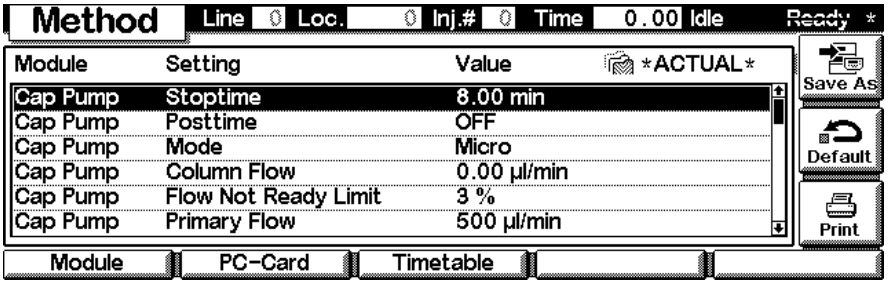
Press **F6** (**Select**) to configure online signals (maximum are 3). Additional signals can also be chromatograms or temperature signals from other modules. Use the **Right/Left** selection keys to switch between 'Available Signals' and 'Selected Signals'. Use the **F8**-key (**Move**) or **Enter** to move available signals into the box for selected signals or vice versa. Use **F7** to **Setup** ranges for each individual (highlighted) signal. Press **F6** (**Done**) to activate the changed settings and to return to the **Plot** screen.



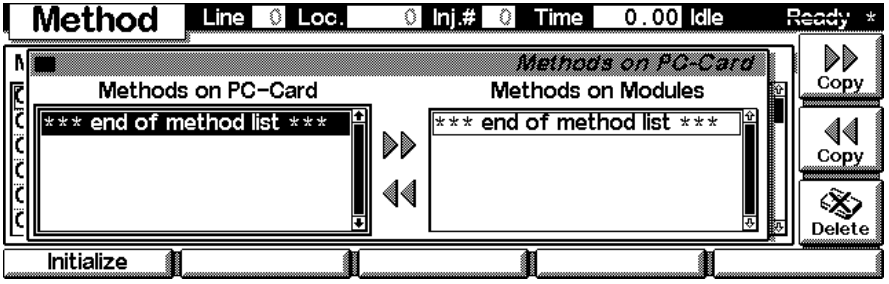
## Method screens

On the **Analysis** screen use the **F3**-key (**Method**) to view the parameters in a method. Use the **F8**-key (**Save As**) to save the method in the module(s). The PC-Card-key (**F2**) is only active when a PCMCIA card is inserted in the control module.

NOTE The PCMCIA card is only recognized, if inserted before last start-up.

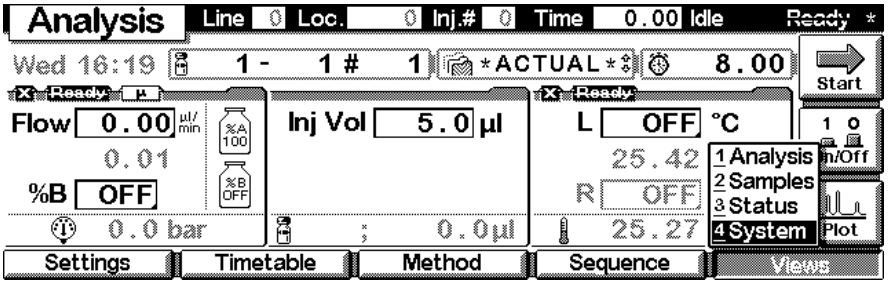


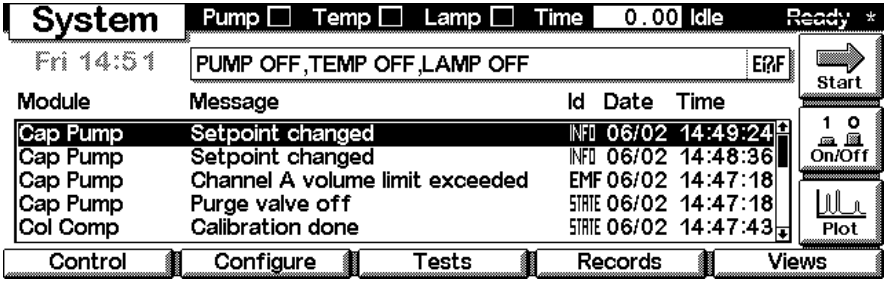

Use **F2**-key (**PC-Card**) to transfer a method from/to a PCMCIA card. Use the **Right/Left** selection keys to switch between PC-Card and Instrument window. Use the **Up/Down** selection keys to select the method. Use the **F7/F8**-keys (**Copy**) or **Enter** to move available methods between PCMCIA card and Modules. **F6 Delete**s a selected method.



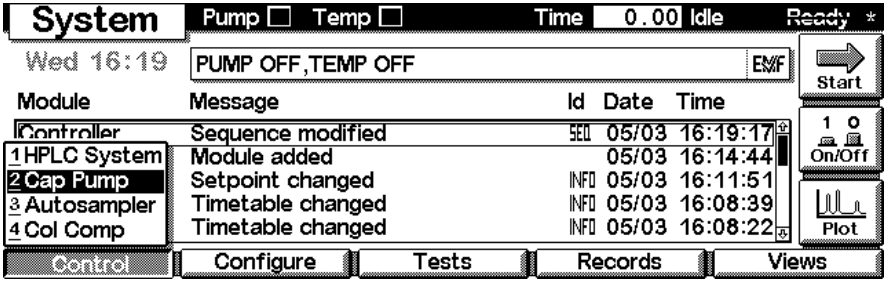
## Screens available from the System view

**System view** Use the **Esc**-key to until you receive **Views** on the **F5**-key. Choose **System** from the pull-down menu. This screen shows the last activities in the system.

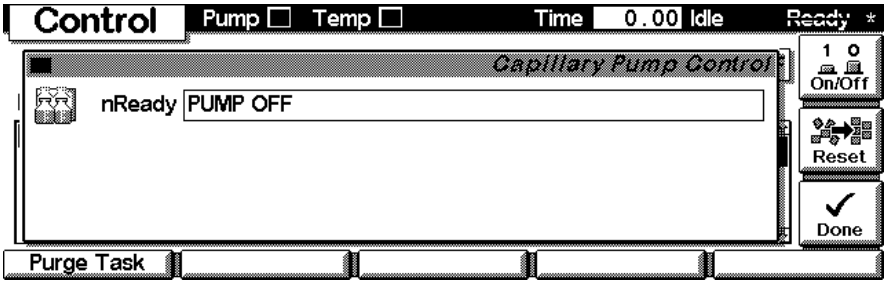


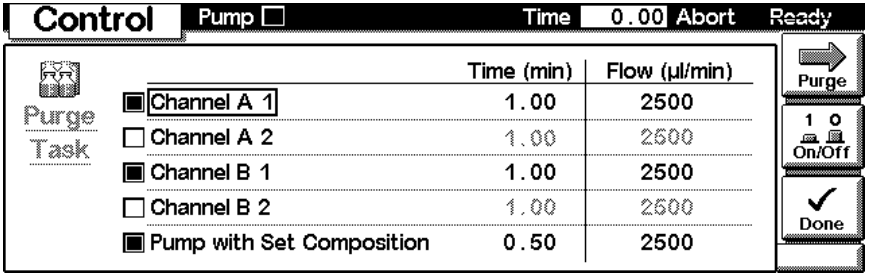

**System - Control** Use the **F1**-key (**Control**) and select the capillary pump.



In the capillary pump's Control screen, you can turn **On or Off** (**F8**) the pump, or **Reset** (**F7**) the pump. Here you receive information about the not-ready conditions if needed.

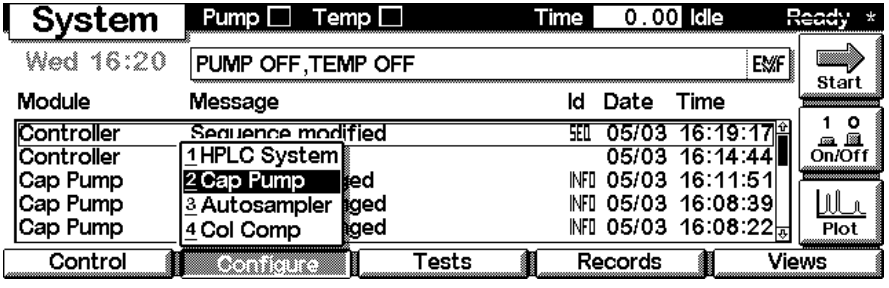



Use **F1** (**Purge Task**) to access the pump's Purge Task. After selecting a channel, you can edit its **Purge Time** and **Flow Rate**. Use **F8** (**Purge**) to start/stop the Purge Task as defined or define the settings for the next Purge Task. Changes must be activated with **F6** (**Done**).

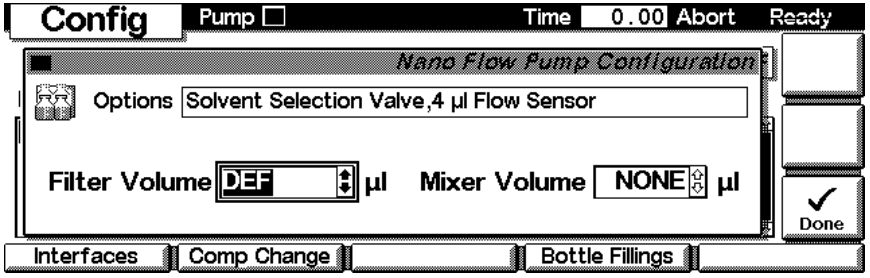


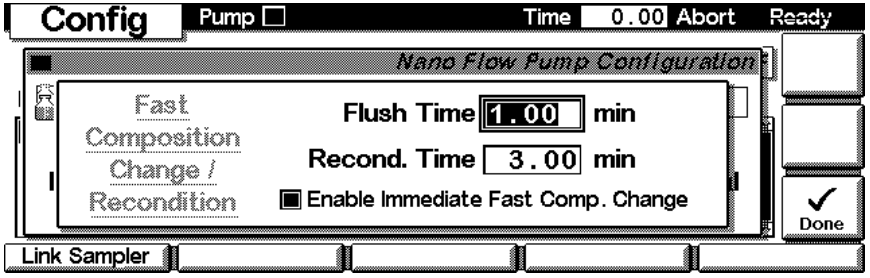

**System - configuration**

On the **System** screen use the **F2**-key (**Configure**) and select the pump.

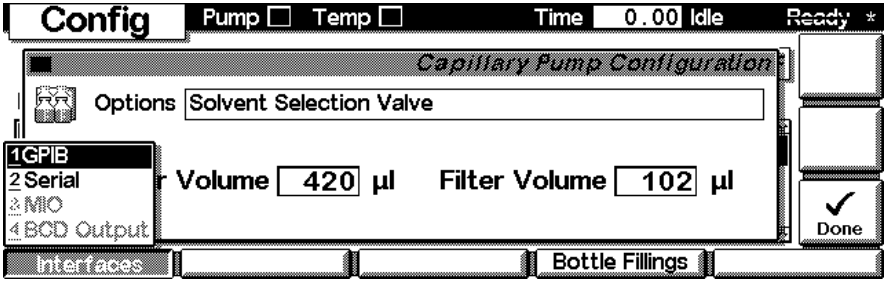


This screen gives you information about installed options and allows you to configure your pump to the filter and mixer type that is actually installed in the pump. Changes must be activated with **F6** (**Done**).



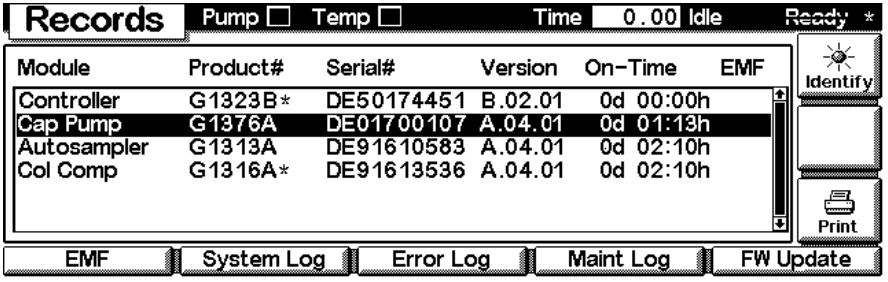

Press **F2** to edit and enable/disable 'Immediate Fast Composition Change'.



# Screens available from the Records screen

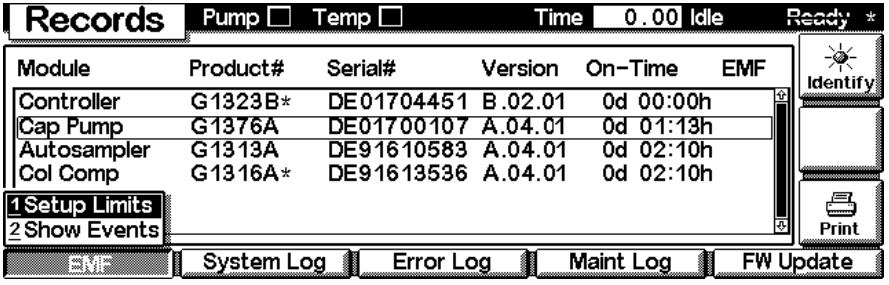
**Records screen**

Use the **Esc**-key until you receive **Views** on the **F5**-key. Choose **System** from the pull-down menu. Use the **F4**-key (**Records**) and select the pump. Errors are reported either into the **F2** (**System Log**) or **F3** (**Error Log**).

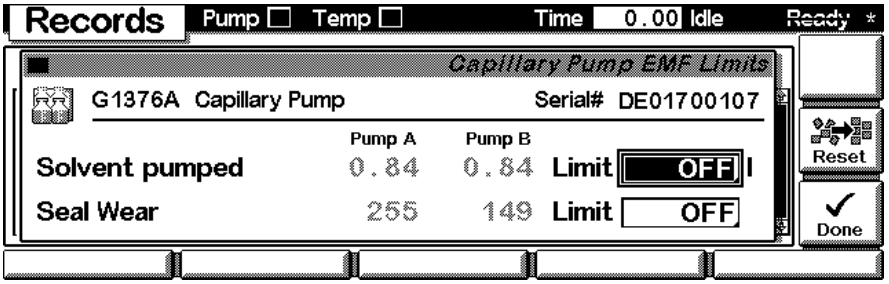



**EMF Early Maintenance Feedback)**

Use the **F1**-key (**EMF**) to set EMF **Limits**. Choose menu item **Setup Limits** to set the amount of pumped solvent or seal wear, when you want to receive a warning for exceeded limits.



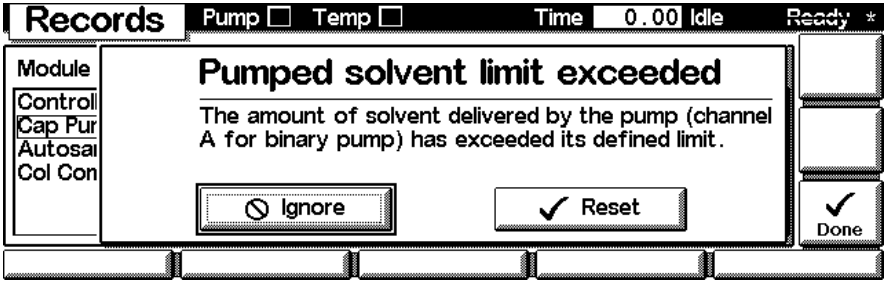

Press **F7** (**Reset**) to reset the counters after exchanging parts that are subject to wear. Changes must be activated with **F6** (**Done**).



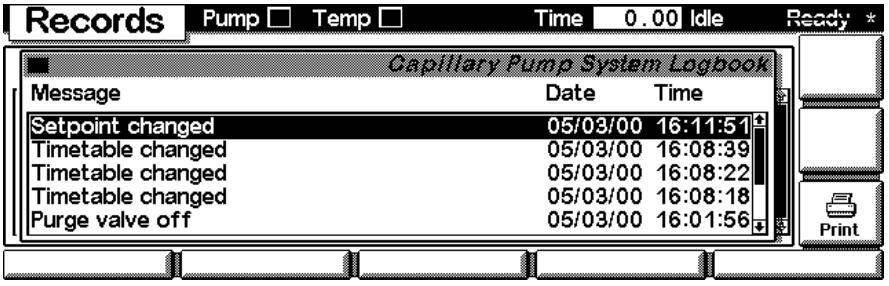

If a set limit has been exceeded, a message box will pop up.

NOTE An exceeded limit will not stop a sequence or run (information only, to plan maintenance activities).

If you press **Reset**, the limits will be removed. **Ignore** will continue to keep the EMF flag set.

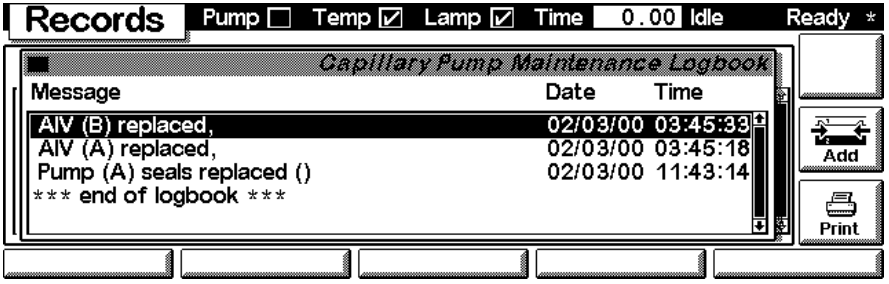



**System / Error Log** Use the **F2**-key (**System Log**) or **F3**-key (**Error Log**) to look for errors on the selected/ highlighted module.

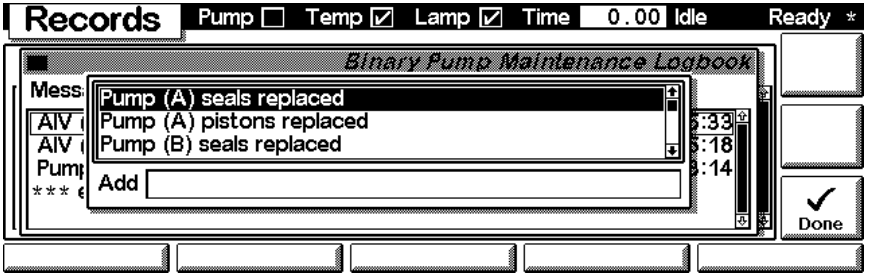



## Maintenance Log

Use the **F4**-key (**Maint Log**) to review and enter maintenance activities in the maintenance logboo0k.

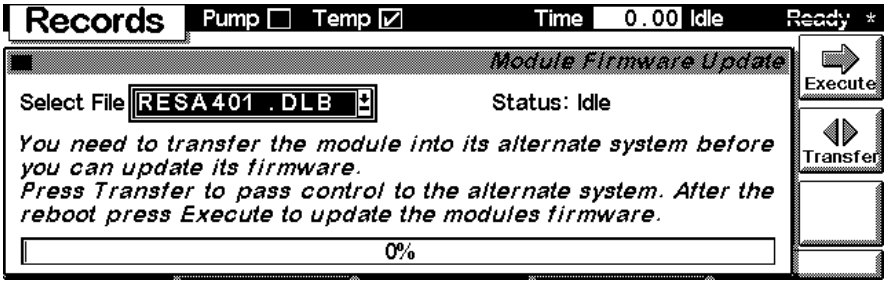



Use the **F7**-key (**Add**) to add new maintenance activities. You can add a comment to the activity into the line ‘Add’ using the control modules **alphanumeric** keys. Changes must be activated with **F6** (**Done**).

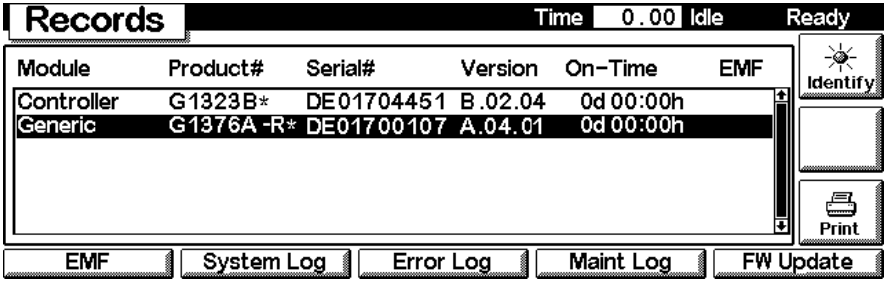


### Firmware Update

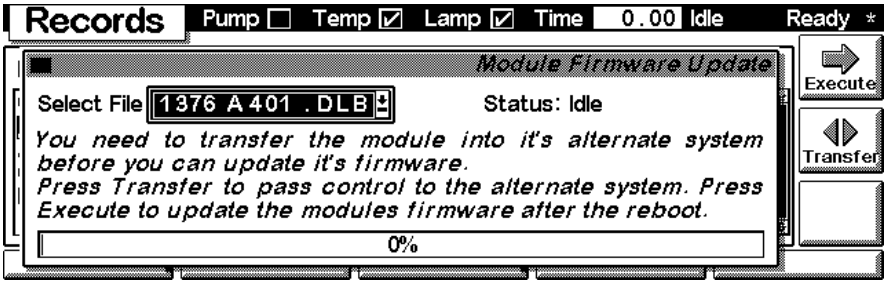
Use the **Esc**-key to receive **Views** on the **F5**-key. Choose **System** from the pull-down menu. Use the **F3**-key (**Records**) to select the pump. Use the **F5**-key (**FW Update**) to enter the Update section. If you want to update the resident firmware (together with specific main firmware revisions), select the file from the PCMCIA card (RESnnnn.DLB) and press execute. If you want to update the main firmware, press **F7**-key (**Transfer**) to turn the module into the resident mode (LED on module should blink yellow).



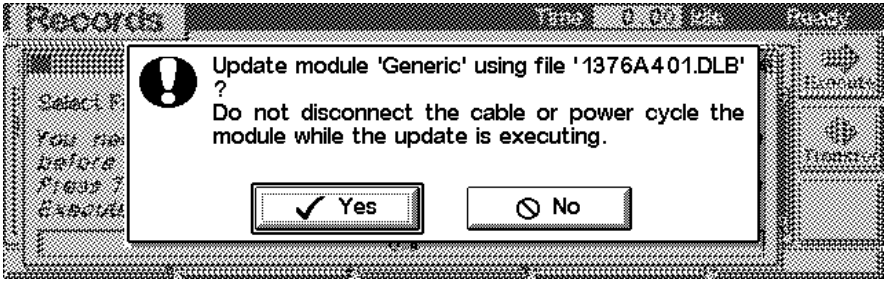

Use the **Esc**-key to receive **Views** on the **F5-key**. Choose **System** from the pull-down menu. Use the **F3**-key (**Records**) to select the **Generic** module. In this screen the resident firmware revision is shown.




Use the **F5**-key (**FW Update**) to enter the Update section. Select the a file from the PCMCIA card (1376nnnn.DLB) and press execute. When the update has finished, press **F7**-key (**Transfer**) to return the module into the normal mode (LED on module should stay yellow).

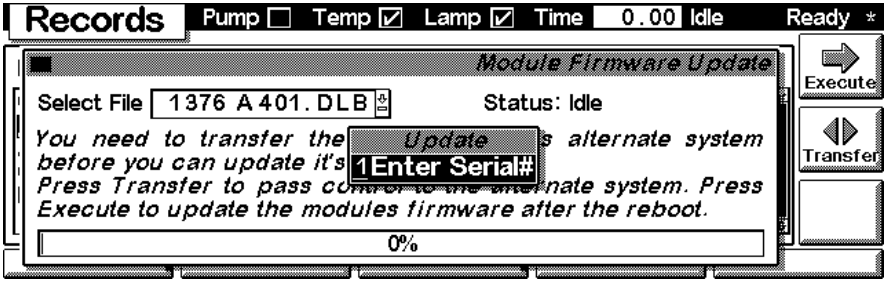



If you have not saved your methods, please do it before continuing. Otherwise they will be overwritten during the update process.

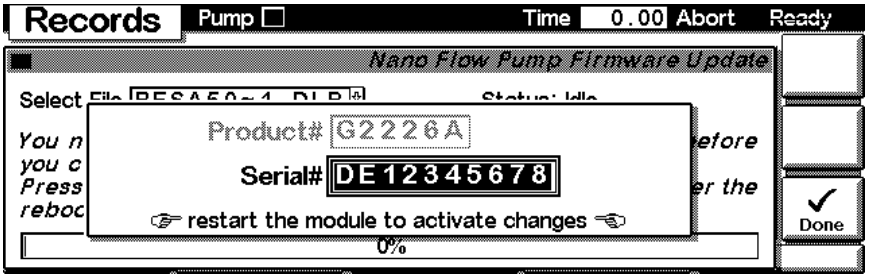

Update module 'Generic' using file '1376A401.DLB' ?
Do not disconnect the cable or power cycle the module while the update is executing.
Yes
No

**Changing the serial number**

In case the serial number of the module has to be added, use the **m**-key to open the menu **Enter Serial#**. The serial number becomes active after restart of the module.



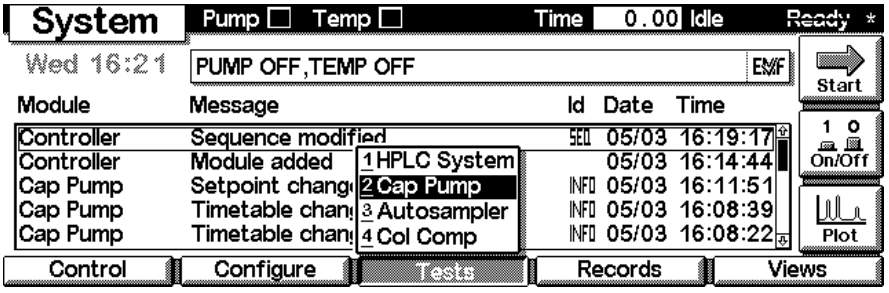

Type in the module's Serial# as indicated on the front or rear label of the module using the alphanumeric keys. Changes must be activated with **F6** (**Done**).

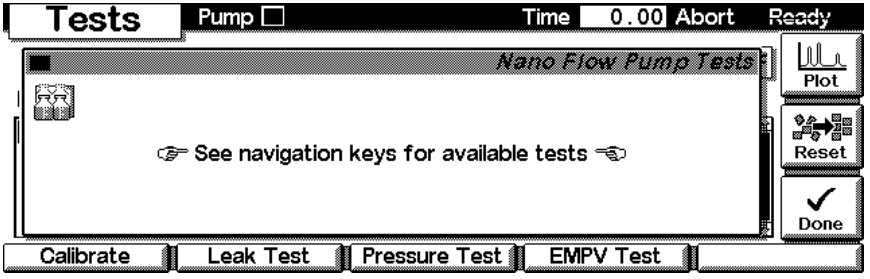

Records
Pump
Time
0.00
Abort
Ready
Nano Flow Pump Firmware Update
Select
Product# G2226A
Serial# DE12345678
restart the module to activate changes
0%
Done

# Diagnostics and Tests

**Tests screen**

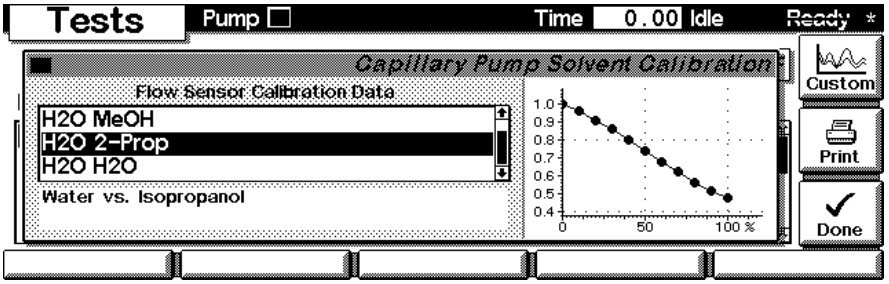
Use the **Esc**-key until you receive **Views** on the **F5**-key. Choose **System** from the pull-down menu. Use the **F3**-key (**Tests**) to select the pump.



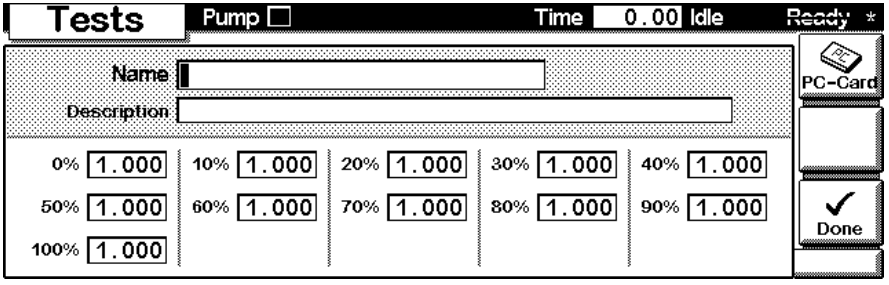




**Calibration**

Press **F1** (**Calibrate**) to access the pump's calibration screen. Select one of the calibration curves stored on the module with the help of the selection keys.

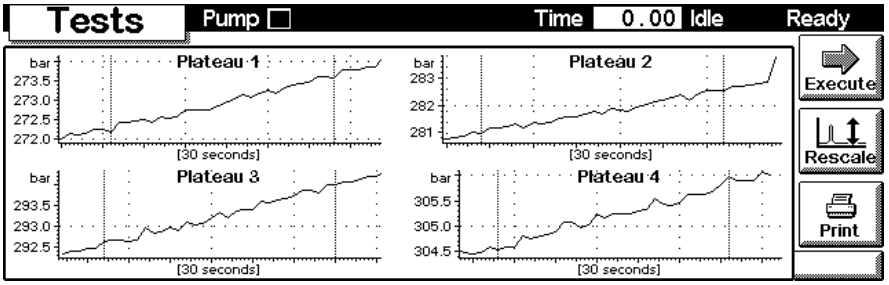



Press **Enter** once you have selected/highlighted a calibration curve to edit the individual data points of this curve. Editing the name of the curve and acknowledging the changes with **F6** (**Done**) saves the new data curve with its new name. It is possible to store one individually created calibration curve with each method. Load/Save a calibration curve from/to the PCMCIA-Card by pressing **F8** (**PC-Card**).



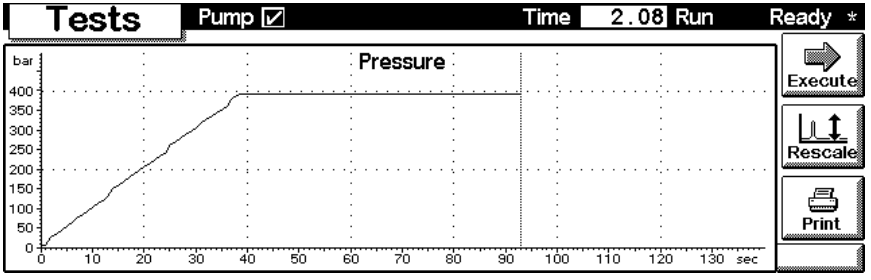

### Leak Test

Press **F2** (**Leak Test**) on the Test screen to perform a leak test. Several steps like purging the system, setting up Isopropanol as solvent on the channel that is supposed to be tested and blocking the purge valve outlet with a blank nut have to be performed before operating the leak test. For details use the **i**-key to achieve context sensitive help, follow the instructions on the screen and refer to "Running the Leak Test" on page 74. For evaluating the leak test refer to "Evaluating the Results of the Leak Test" on page 77.




**Pressure Test**

Use the **F3**-key (**Pressure Test**) to perform a pressure test of the system. Several steps like purging the system, setting up Isopropanol as solvent on channel A or A2 (if solvent selection valve is installed) and blocking the column outlet with a blank nut have to be performed before operating the pressure test. For details use the **i**-key to achieve context sensitive help, follow the instructions on the screen and refer to "Running the Normal Mode Pressure Test" on page 69. For evaluating the pressure test refer to "Evaluating the Results" on page 71.



# 7 Specifications

Performance Specification Agilent 1100 Series Nano Pump 258
Performance Specification Agilent 1100 Series Micro Degasser 259

# Performance Specifications

**Table 63** Performance Specification Agilent 1100 Series Nano Pump

| Type | Specification |
|---|---|
| Hydraulic system | Two dual piston in series, with proprietary servo-controlled variable stroke drive, floating piston, active inlet valve, solvent selection valve and electronic flow control for flow rates from 0.1 to 1 µl/min |
| Settable column flow range | 0.01 – 4 µl/min<br>1 – 2500 µl/min (with the electronic flow control bypassed) |
| Recommended column flow range | 0.1 – 1 µl/min<br>200 – 2500 µl/min (with the electronic flow sensor bypassed) |
| Optimum composition range | 1 to 99% or 5 µl/min per channel (primary flow), whatever is greater |
| Composition precision | < 0.2 % SD, at 500 nl/min (default settings),<br>Minimum primary flow/pump channel is 5 µl/min |
| Delay volume | Typically 300 nl from the electronic flow control to the pump outlet for flow rates up to 4 µl/min. For flow rates up to 4 µl/min and electronic flow control active: primary flow path 180 - 480 µl; system pressure dependent (default settings; calculated volume)<br>Typically 180 to 480 µl (system pressure dependent) for flow rates up to 2.5 ml/min. (default settings; calculated volume) |
| Pressure range | 20 to 400 bar (5880 psi) system pressure |
| Compressibility compensation | User-selectable, based on mobile phase compressibility |
| Recommended pH range | 1.0 – 8.5, solvents with pH < 2.3 should not contain acids which attack stainless steel. Upper pH range is limited by fused silica capillaries. |
| Control and data evaluation | Agilent ChemStation for LC |
| Analog output | For pressure monitoring, 2 mV/bar, one output |
| Communications | Controller-area network (CAN), GPIB, RS-232C, APG Remote: ready, start, stop and shut-down signals, LAN optional |

**Table 63** Performance Specification Agilent 1100 Series Nano Pump, continued

| | |
|---|---|
| Safety and maintenance | Extensive diagnostics, error detection and display (through control module and Agilent ChemStation), leak detection, safe leak handling, leak output signal for shutdown of pumping system. Low voltages in major maintenance areas. |
| GLP features | Early maintenance feedback (EMF) for continuous tracking of instrument usage in terms of seal wear and volume of pumped mobile phase with user-settable limits and feedback messages. Electronic records of maintenance and errors. |
| Housing | All materials recyclable. |

**Table 64** Performance Specification Agilent 1100 Series Micro Degasser

| Type | Specification |
|---|---|
| Maximum flow rate | 5 ml/min per channel |
| Number of channels | 4 |
| Internal volume | Typically 1 ml per channel |
| Internal design | One chamber per channel with optimized flow path for fastest solvent change over |
| Material in contact with solvents | PTFE, FEP, PEEK |

# 7 Specifications

# A
# Safety Information

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The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

## General

This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

**WARNING** **This instrument is designed as a laboratory equipment. Use it in an analytical environment only.**

**Use this instrument in a manner described in this manual.**

## Operation

Before applying power, comply with the installation section. Additionally the following must be observed.

Do not remove instrument covers when operating. Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers, and devices connected to it must be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any intended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, and so on) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

**WARNING** **Any adjustment, maintenance, and repair of the opened instrument under voltage is forbidden.**

**WARNING** **Disconnect the instrument from the line and unplug the power cord before maintenance.**

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not install substitute parts or make any unauthorized modification to the instrument.

Capacitors inside the instrument may still be charged, even though the instrument has been disconnected from its source of supply. Dangerous voltages, capable of causing serious personal injury, are present in this instrument. Use extreme caution when handling, testing and adjusting.

## Safety Symbols

Table 65 shows safety symbols used on the instrument and in the manuals.

**Table 65** Safety Symbols

| Symbol | Description |
|---|---|
| | The apparatus is marked with this symbol when the user should refer to the instruction manual in order to prevent risk of harm to the operator and to protect the apparatus against damage. |
| | Indicates dangerous voltages. |
| | Indicates a protected conductor terminal. |
| | Eye damage may result from directly viewing the light produced by the Xenon flash lamp used in this product. Always turn the xenon flash lamp off before removing it. |

**WARNING**

**A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death.**

**Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.**

**CAUTION**

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data.

Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

# Lithium Batteries Information

**WARNING** **Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the equipment manufacturer. Lithium batteries may not be disposed-off into the domestic waste.**

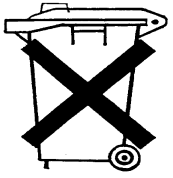
**Transportation of discharged Lithium batteries through carriers regulated by IATA / ICAO, ADR, RID, IMDG is not allowed. Discharged Lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.**

## Danish Information

**WARNING** **Lithiumbatteri - Eksplosionsfare ved fejlagtic handtering. Udskiftning ma kun ske med batteri af samme fabrikat og type. Lever det brugte batteri tilbage til leverandoren.**

**WARNING** **Lithiumbatteri - Eksplosionsfare. Ved udskiftning benyttes kun batteri som anbefalt av apparatfabrikanten. Brukt batteri returneres appararleverandoren.**

NOTE Bij dit apparaat zijn batterijen geleverd. Wanneer deze leeg zijn, moet u ze niet weggooien maar inleveren als KCA.



# Radio Interference

Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

## Test and Measurement

If test and measurement equipment is operated with equipment unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the radio interference limits are still met within the premises.

# Sound Emission

## Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive of 18 January 1991.

This product has a sound pressure emission (at the operator position) < 70 dB.

- Sound Pressure Lp < 70 dB (A)
- At Operator Position
- Normal Operation
- According to ISO 7779:1988/EN 27779/1991 (Type Test)

# Solvent Information

Observe the following recommendations on the use of solvents.

## Solvents

Brown glass ware can avoid growth of algae.

Always filter solvents, small particles can permanently block the capillaries. Avoid the use of the following steel-corrosive solvents:

- Solutions of alkali halides and their respective acids (for example, lithium iodide, potassium chloride, and so on).
- High concentrations of inorganic acids like nitric acid, sulfuric acid especially at higher temperatures (replace, if your chromatography method allows, by phosphoric acid or phosphate buffer which are less corrosive against stainless steel).
- Halogenated solvents or mixtures which form radicals and/or acids, for example:

  $2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$

  This reaction, in which stainless steel probably acts as a catalyst, occurs quickly with dried chloroform if the drying process removes the stabilizing alcohol.

- Chromatographic grade ethers, which can contain peroxides (for example, THF, dioxane, di-isopropylether) such ethers should be filtered through dry aluminium oxide which adsorbs the peroxides.
- Solutions of organic acids (acetic acid, formic acid, and so on) in organic solvents. For example, a 1-% solution of acetic acid in methanol will attack steel.
- Solutions containing strong complexing agents (for example, EDTA, ethylene diamine tetra-acetic acid).
- Mixtures of carbon tetrachloride with 2-propanol or THF.
- Avoid the use of alkaline solutions (pH > 8.5) which can attack the fuse silica from the capillaries.

# Agilent Technologies on Internet

For the latest information on products and services visit our worldwide web site on the Internet at:

http://www.agilent.com

Select “Products” - “Chemical Analysis”

It will provide also the latest firmware of the Agilent 1100 series modules for download.

# A Safety Information

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## In This Book

This manual contains technical reference information about the Agilent 1100 Series Nano pump. The manual describes the following:

- installation,
- optimizing performance,
- diagnostics and troubleshooting,
- repairing,
- parts and materials,
- introduction to the pump, theory of operation,
- screens of the local control module and
- specifications.

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